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Analisi Tecno-Economica di un Caso Reale di Comunità Energetiche con l'uso di LCCA e strumenti di analisi energetica per ottimizzare la produzione di energia rinnovabile e il suo utilizzo.

Techno-Economic Analysis of Real Case of Energy Communities with use of LCCA and Energy Analysis Tool for optimizing the Production of Renewable Energy and its Use

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I. Introduction

I.1. General context

The effect of climate change on the environment and society are becoming increasingly evident year by year. Although Italy has experienced significant economic damage attribute to climate change, it is not currently among the hardest hit globally. Instead, the United States and Philippines are identified as the most economically impacted countries due to climate-related disasters. Theres is a direct and linear correlation between the increase in CO2 in the atmosphere and the rise in global temperature.

The European Union has set the goal of reducing CO2 emissions by at least 55% by 2030 compared to 1990 [1]. In Italy, for the electricity sector, meeting these targets means increasing the share of renewable energy from around 45% to over 70% of electricity demand by 2030 this ambitious goal requires a significant increase in installed renewable power, estimated at 70 GW. When added to the currently installed approximately 60 GW of power, this bring the total renewable power to 125 GW, to be achieved by 2030. [2]

The hope is that by 2050, most of Italian energy will come from renewable sources. However, planning and constructing new large-scale energy infrastructures require time and adequate spaces, the construction of large-scale plants requires extensive areas, often unavailable in our territory and more complex authorization processes (landscape constraints, environmental impact assessment, esc…);on the contrary, small-sized plants on building roofs are more easily authorized, even in a short time, and allow for the use of many available roof with virtually no land use. This better accessibility of small-scale plants perfectly aligns with Renewable Energy Communities (REC), Which combine the advantages of installing new plants with the benefits of self-consumption of energy.

Europe still has a significant dependency on fossil fuels, leading to substantial volatility in energy costs, depending on geopolitical or market changes. Modern technology allow access to sustainable solutions, whose dissemination must be encouraged to achieve the 2030 goals: offshore or onshore wind, agricultural or rooftop photovoltaics, biomethane, energy efficiency, are all essential tools to tackle the ecological transition, to which the spread of Renewable Energy Communities must also be added.

A study conducted by Elements for ***Legambiente*** has estimated that by 2030, the contribution of Energy Communities to new renewable power in Italy could reach around 17 GW, allowing the generation of 22.8 TWh annually of renewable electricity, corresponding to 30% of the energy increase expected by the PINEC (National Integrated Plan for Energy and Climate 2030) to meet the new European decarbonization targets [3].

I.2. The importance of sustainability and energy efficiency

Sustainability is essential for minimizing the environmental impact of energy production and consumption. By prioritizing renewable energy sources, we reduce greenhouse gas emissions and pollution, helping to mitigate climate change and protect ecosystems. Sustainable practices ensure the conservation of natural resources, as renewable energy sources such as wind, solar, and hydroelectric power are abundant and less damaging to the environmental compared to fossil fuels. This conservation is essential for maintaining biodiversity and ensuring resources are available for future generations.

Additionally, sustainable energy system provides economic benefits by creating jobs in renewable energy sectors and reducing energy costs over time, while also enhancing energy security by reducing dependence on imported fuels and stabilizing energy prices

Energy efficiency measures reduce the overall demand for energy, which helps achieve the ambitious goals set for renewable energy adoption by making existing energy infrastructure more effective and reducing the need for the additional capacity. Implementing energy-efficient technologies leads to significant cost saving for consumers and businesses by lowering energy bills, and these savings can be reinvested into further sustainability initiatives, creating a positive feedback loop. Furthermore, enhancing energy efficiency reduces reliance on imported energy, thereby improving national energy security and ensuring that available energy resources are used optimally. Minimizing the risk of energy shortages.

Energy efficiency also plays a key role in reducing greenhouse gas emissions and other pollutants by decreasing the amount of fuel needed, thus lowering emissions and mitigating the impact on climate change.

II. Renewable Energy Communities (RECs)

II.1. What is an energy community?

A Renewable Energy community (REC) is an association composed of various citizens, companies, local businesses and territorial government agencies that choose to join for the purpose of producing electricity from renewable source and by doing so are able to meet their own needs with a clean, affordable and locally produced alternative.

II.2. For what purpose is an REC created?

Renewable Energy Communities offer an innovative and participatory response to the need of the current energy market, but they also represent a virtuous example of how people can actively contribute to the energy transition and combat climate change.

In fact, through energy communities it is possible to reduce CO2 emissions and energy waste while at the same time decreasing spending related to energy consumption.

In addition, when the production of electricity exceeds the needs of self-consumption, the energy community can act as a supplier on the market, offering their excess electricity for sale and generating income for all the community members.

II.3. Benefits

In line with the Sustainable Development Goals (SDGs) of the UN 2030 Agenda, energy communities initiate transversal benefits from an environmental, economic and social point of view.

Energy communities present a virtuous model where electricity is produced in a responsible way and consumed conscientiously. They are true hubs where “zero-mile” energy is produced without emitting CO2 into the atmosphere and then distributed locally to citizens and companies that are part of the same region.

The economic benefits of the energy community include several key aspects:

- ***Individual self-consumption:*** *Allows avoiding payment of the variable parts of transportation and system charges for the self-produced and self-consumed electricity. This results in total savings as it is not paid on the bill.*
- ***Community Self-Consumption:*** *includes the share of energy shared within the energy community, values through the refund of low voltage transmission tariff components and the higher value of the variable distribution component for low voltage users (TRASE+BTAU). The value of these components varies over time but is around 8_9€/MWh.*
- ***Incentive for Shares Electricity:*** *Through the premium tariff defined by MiSE on the share of energy shared produced by eligible plants, equal to 110€/MWh. [4]*
- ***Remuneration for Energy Fed into the Grid:*** *All energy fed into the grid, whether shared or supplied, is remunerated at the zonal hourly price (around 50-90 €/MWh), for example, through the dedicated withdrawal by GSE.*
- ***Tax Deduction:*** *for eligible users, the premium tariff can be combined with a 50% tax deduction for the installation of new photovoltaic plants, up to a maximum of 96,000€. [5]*

This results in significant saving on utility bills, which in some cases can even match or exceed the amount paid to join the energy community.

In social benefits the energy communities can develop the local productive sector, creating new jobs for the community and facilitating the energy independence of a territory, region or entire country. This is in line with a broader energy transition process in which green energy is not just economically advantageous but becomes a tool capable of ensuring equity and security.

III. Regulatory Framework

The field of energy communities since 2008 is under European regulation, which aims to guarantee a correct implementation of the E.C and their incentive. These regulations were subsequently incorporated into Italian legislation and refined at regional level

III.1. European regulation

Since the inception of the European Union, energy management and environmental protection have been integral to European policy, closely intertwined. In 2008, the EU introduced its first comprehensive set of measures specifically designed to address energy and environmental challenges, with a primary focus on improving efficiency. The European Commission recognized the necessity of these objectives, both to combat the well-documented issue of global warming and to reduce the EU's reliance on energy imports from non-EU countries.

To illustrate the significance of this dependency, in 2012, the cost of importing gas and oil for EU member states amounted to 400 billion euros, representing 3.1% of the European gross domestic product (GDP) that year. Additionally, the rapid economic growth of countries like China and India has disrupted the global energy market, driving up the cost of primary energy resources to the disadvantage of European buyers. [6]

In this context, European policy has been developed around several key principles essential for achieving its objectives. The main principles of the European regulatory framework are:

a) ***Ambitious Commitment to Greenhouse Gas Reduction:*** *Aligning with the 2050 roadmaps, Europe is committed to significantly reducing greenhouse gas emissions.*
b) ***Simplification and Improvement of the Policy Framework:*** *Enhancing the coherence and complementarity of existing policies while simplifying the regulatory landscape.*

c) ***Flexibility for Member States:*** *Allowing each country to define a transition to a low-carbon system that suits its national circumstances, chosen energy mix, and energy security needs, while keeping costs to a minimum.*
d) ***Strengthened Regional Cooperation:*** *Encouraging collaboration among Member States to address common energy and climate challenges more cost-effectively.*
e) ***Efficient Development of Renewable Energies:*** *Building on the momentum of renewable energy advancement by defining policies that promote efficiency.*
f) ***Energy Security and Low-Carbon Transition:*** *Facilitating the transition to a competitive, low-carbon energy system through joint actions, market integration, import diversification, sustainable development of indigenous energy sources, infrastructure investments, energy savings, and support for research and innovation.*
g) ***Fair Distribution of Efforts:*** *Ensuring that efforts are fairly distributed among Member States, reflecting their specific circumstances and capabilities.*

Based on these principles, the European regulatory framework has been continuously integrated with various directives addressing different energy-related themes. Key directives include [7]:

- ***Renewable Energy Directive (2009/28/EC)***
- ***Energy performance of buildings Directive (2010/31/EU)***
- ***Energy efficiency Directive (2012/27/EU)***
- ***Internal electricity market Directive (2009/72/EC)***
- ***Internal electricity gas market Directive (2009/73/EC)***

In addition to these directives, European institutions have continued to refine and update the regulatory framework through new directive packages. The most significant package related to energy communities was introduced in 2019 under the name "*Clean Energy Package*".

III.1.1. Clean Energy Package

In 2019, the European Commission introduced the "**European Plan on Climate Change**," commonly referred to as the "**Clean Energy Package**" **(CEP)**. This comprehensive package includes four directives and four regulations, establishing legal frameworks for specific categories of energy community [8]. The key components of the CEP are as follows:

- **Energy Performance of Buildings Directive (EU) 2018/844**
- **Renewable Energy Directive (EU) 2018/2001**
- **Energy Efficiency Directive (EU) 2018/2002**
- **Governance of the Energy Union and Climate Action Regulation (EU) 2018/1999**
- **Electricity Regulation (EU) 2019/943**
- **Electricity Market Directive (EU) 2019/944**
- **Regulation on Risk-Preparedness in the Electricity Sector (EU) 2019/941**
- **Regulation on the European Union Agency for the Cooperation of Energy Regulators (EU) 2019/942**

As discussed later, the field of energy communities is particularly influenced by both the **Renewable Energy Directive (EU) 2018/2001** and **the Electricity Market Directive (EU) 2019/944.**

The European Plan on Climate Change aims to assist the European Community in achieving its energy production impact reduction goals by 2030. These objectives are summarized as follows:

- **32%** of energy consumption from Renewable Energy Sources (RES)
- **32.5%** improvement in energy efficiency

The third goal, initially set to reduce greenhouse gas emissions by 55% by 2030, was updated in June 2021 under Regulation (EU) 2021/1119, known as the "**European Climate Law**." [9] This regulation revises the greenhouse gas reduction targets, establishing the following milestones:

- **55%** reduction in greenhouse gas emissions by 2030
- Achievement of climate neutrality by 2050

To reach these ambitious objectives, the European Commission emphasizes the necessity of integrating a consumer-centric approach to the energy market, thereby increasing citizens' responsibility regarding energy usage and emissions.

III.1.2. Energy communities in EU regulation

With the introduction of the Clean Energy Package (CEP), European legislation for the first time recognized the rights of citizens to participate directly in the energy market, establishing the necessary legal framework to facilitate the spread of collective energy production.

The CEP identifies two key types of energy communities:

a) Renewable Energy Communities: *Defined under the Renewable Energy Directive (EU) 2018/2001, commonly referred to as "RED II." RECs are characterized by member autonomy and the proximity of energy sources. These communities can manage various types of energy «electricity, thermal energy, and gas» if they are generated from renewable sources [10].*

b) Citizen Energy Communities: *Defined under the Internal Electricity Market Directive (EU) 2019/944. CECs are focused only on electricity, which can be produced from both renewable and non-renewable sources. Unlike RECs, CECs are not bound by principles of autonomy and proximity [11].*

Both the Renewable Energy Directive and the Electricity Market Directive recognize energy communities as legal entities grounded in public and voluntary participation. These communities can be organized in various forms, such as cooperatives, associations, and more. The key characteristic of these market actors is that their primary objective is not to generate economic profits but to deliver economic, social, and environmental benefits to their members. The principle of public participation ensures that these projects are open to all potential members. Additionally, participants should be able to leave the energy community without losing access to the energy network managed by the community.

Despite being described in two different regulations, renewable energy communities (RECs) and citizen energy communities (CECs) differ in several respects [12]. Below are the main differences between them, based on the Renewable Energy Directive for RECs and the Electricity Market Directive for CECs:

a) **Participants**: In CECs, natural persons, local authorities, and companies of all sizes can participate. In contrast, RECs have more restrictive participation criteria, accepting only natural persons, local authorities, and small or medium-sized enterprises (SMEs), provided that the energy sector is not their primary business focus.

b) **Activities**: CECs can manage only electricity, whether sourced from renewable or non-renewable energy. On the other hand, RECs can manage various forms of energy, such as electricity, thermal energy, and gas, but only if these are sourced from renewables.

c) **Geographical Scope**: RECs adhere to the principle of locality, meaning they must be developed in proximity to their energy sources. In contrast, CECs do not have geographical limitations.

d) **Autonomy**: RECs are required to remain autonomous from traditional market actors participating in the community. CECs, however, do not require autonomy, but decisions must be made by members who are not associated with large-scale commercial activities or other energy production-focused activities.

e) **Effective Control**: Renewable energy communities can be controlled by their members such as natural people, local authorities, and small or medium companies. For the citizen energy communities, the control is more detailing from the Electricity Market Directive as ≪ *the possibility of exercising decisive influence on an undertaking. In particular by: (a) the ownership or the right to use all or part of the assets of an undertaking, (b) the rights or contracts which confer decisive influence on the composition, voting or decisions of the organs of an undertaking.* ≫ [13]

III.1.3. European Green Deal

The European Green Deal (EGD) is a comprehensive set of policy initiatives proposed by the European Commission in 2019, aimed at achieving climate neutrality in Europe by 2050. Beyond its focus on climate change, the EGD lays the groundwork for the future economy with strategies addressing the circular economy, building renovation, biodiversity, agriculture, smart mobility, and innovation. [14]

Although the drafting process of the EGD is ongoing, the primary goals concerning environmental and energy issues are as follows:

a) ***Enhanced European Climate Ambitions for 2030 and 2050:*** *The EGD sets ambitious targets for a 55% reduction in greenhouse gas emissions by 2030, leading to climate neutrality by 2050.*

b) ***Modernization of European Energy Regulation****: This includes the development of a fully digitized and connected energy market, integrating new technologies and smart systems.*

c) ***Expansion of Renewable Energy Sources****: The EGD emphasizes the growth of offshore wind farms and other renewable energy sources as the foundation of the European energy system.*

d) ***Ensuring Affordable Energy Supply****: A key goal of the EGD is to secure an affordable and reliable energy supply across the EU.*

e) ***Innovation in the Construction Sector****: The EGD promotes significant advancements in the construction sector to improve the energy efficiency of buildings, contributing to overall emissions reductions.*

III.2.Italian Regulation

The establishment of an energy community as a legal entity is regulated by decree-law 162/19(article 42-bis) and by its related implementation measures, such as the ARERA resolution 318/2020/R/eel and the MINISTRY OF ECONOMIC DEVELOPMENT's DM of September 16,2020. [15]

The Italian legislation includes the recommendations regarding renewable energy communities that are found withing the broader European Directive No.2001 of December 11,2018 ("Renewable Energy Directive Recast"), otherwise known as REDII. This directive outlines the modalities and specific constraints that an REC is required to meet the regarding energy sustainability. [15]

Through Legislative Decree 199/2021, the Italian government wanted to encourage an increasingly widespread use of renewable source and at the same time the size of plants (overall power capacity of no more than 1MWp) and their range of operation (plants must be connected to the electricity grid through the same primary substation). [16]

The Renewable Energy Community regulatory framework is outlined by ARERA in the December 2022 publication of its resolution **“Widespread Self-Consumption Integrated Text/Testo Integrato Autoconsumo Diffusi” (TIAD).**

A further step towards completing the regulatory framework will be entrusted to the issuance of the **MaSE Decree** on incentives, which will be closely followed by **Gestore dei Servizi Energetici/Energy Services Manager (GSE)** publication of **technical operating rules for RECs and self-consumption.** [17]

These regulations establish **the ways through which members of an energy community can utilize shared energy.** With this definition the amount of energy equal to the minimum, on an hourly basis, is identified as between the electricity fed into the grid by generating plants and the electricity withdrawn by consumers that they detect for the configuration.

The community’s shared energy also benefits from an economic contribution and incentives given by the **GSE**.

III.3. Regional Regulation

Energy communities typically operate within a local context, developing systems that are autonomous and must align closely with specific regional regulations. Each region is responsible for creating its regulatory framework, tailored to the unique characteristics and needs of its area. This authority is provided by Article 117 of the Italian Constitution [18], which allows regions to legislate on this matter, provided that regional laws adhere to the fundamental principles established by state law and do not conflict with regulations and obligations stemming from the European Community system.

Several regions, such as Piedmont, Puglia, Sardinia, and Liguria, have already implemented laws that support the development of energy communities.

III.4.Economic incentives and tax detraction

In September 2020, the Ministry of Economic Development implemented the economic incentives outlined in Decree-Law No. 162 of December 30, 2019, commonly referred to as the "Milleproroghe" decree. This initiative aims to promote instant self-consumption, the alignment of production and consumption locations, and the use of energy storage systems.

The "Milleproroghe" decree directs the Minister of Economic Development to establish an incentive rate for the remuneration of renewable energy plants [19]. Consequently, on September 15, 2020, the Minister introduced a tariff of economic incentives within the Italian electricity market [20]. These incentives are allocated based on the amount of self-consumed or shared energy as follows:

- **Energy consumed within a collective self-consumption system**: €100/MWh
- **Shared energy within a renewable energy community**: €110/MWh

These incentives are specifically designed for new plants installed after March 1, 2020, and can be combined with other existing incentives for such installations. Additionally, given the reduced distance of energy transport, a reduction in transport fees is also provided:

- **Shared energy for collective self-consumption**: €10/MWh
- **Shared energy within a renewable energy community**: €8/MWh

Further incentives include the purchase by energy providers of any unused energy fed back into the grid at an average rate of €50/MWh. [21]

In addition to these energy-specific incentives, tax concessions are available for the construction of renewable energy plants. Article 16-bis of Decree No. 917/1986 **Testo Unico delle Imposte sui Redditi (T.U.I.R.)** provides for a tax deduction of 36%, which was updated in 2021 to a 50% deduction on expenses related to energy plants, up to a maximum of €48,000 per real estate unit. The tax deduction is distributed over ten years in equal annual instalments. [22]

Furthermore, to stimulate economic recovery following the COVID-19 pandemic, Italy introduced a 110% tax deduction until the end of 2022. However, this bonus is more complex to obtain compared to the 50% deduction. The 110% tax deduction covers certain building works related to energy efficiency, such as insulation improvements, boiler replacement, photovoltaic panel installation, and energy storage system installation. To qualify for this incentive, at least one of three key improvements (boiler replacement, external insulation, or anti-seismic work) must be completed, and the overall energy efficiency of the building must improve by at least two energy classes. [23]

III.5. Requirements for joining a Renewable Energy Community

Any **public or private entity** can actively participate in the creation of Renewable Energy Community.

The members of an energy community can in fact be **individuals or legal entities.** This allows even private citizens (for example, people who live in the same neighbourhood) to organize and promote the development of an REC with the aim of sharing responsibilities and benefits.

III.5.1. Members of a Renewable Energy Community

Renewable Energy Communities (RECs) are legal entities that emphasize active and voluntary participation. Their members or shareholders, who have supervisory powers, may include individuals, small and medium-sized enterprises (SMEs), territorial entities or local authorities (including municipal governments), research and educational institutions, religious groups, third-sector organizations, and environmental protection organizations.

Given that RECs are classified as non-profit entities, a key membership constraint is placed on private companies. Specifically, private companies are permitted to participate in a REC only if their involvement does not constitute their primary commercial or industrial activity.

The following sections will list the various types of members within an energy community and describe their main characteristics.

- ***Consumers in Energy Communities***

Every citizen consumes energy and resources as part of their daily life. Within an Energy Community (EC), even individuals who do not possess energy production systems can participate. These individuals are referred to as **consumers** and represent the most straightforward role within an EC. From the consumer's perspective, they function as standard customers who purchase energy not from the national grid, but from energy produced by other EC members and fed into that grid.

According to European regulations, in **Citizen Energy Communities (CEC)**, consumers can include individuals, local authorities, and companies of all sizes. In contrast, **Renewable Energy Communities (REC)** have more restrictive participation criteria. RECs accept only natural persons and local authorities, and companies can participate only if they are small or medium-sized enterprises (SMEs) and if the energy sector is not their primary business focus. [12, pp. 23-26]

- ***Producers in Energy Communities***

A producer in an Energy Community (EC) is an individual or entity that owns an energy production plant and sells the energy produced, either entirely or in part, to the EC. According to European regulations, it is essential to differentiate between **Renewable Energy Communities (RECs)** and **Citizen Energy Communities (CECs)** [12, pp. 23-26]:

- **Producers in a Renewable Energy Community (REC)**: These producers can manage various types of energy, including electricity, thermal energy, and gas, but only if these are generated from renewable sources. Additionally, similar to consumers, producers in an REC can only be small or medium-sized enterprises (SMEs), and the sale of the energy produced must not be their primary business activity.
- **Producers in a Citizen Energy Community (CEC)**: These producers are limited to managing only electric energy, which can be generated from either renewable or non-renewable sources. Unlike RECs, there are no restrictions on the size of the company that can participate as a producer in a CEC.

- ***Prosumers in Energy Communities***

The prosumer is an emerging and increasingly common figure within energy communities. A prosumer is a member of the EC who not only consumes energy but also produces it through their own energy generation plant. When the prosumer's plant generates more energy than needed, the surplus is sold back to the grid, functioning as a producer. Conversely, when their energy production falls short of their needs, the prosumer can purchase the required energy from the EC grid, similar to a regular consumer.

This dual role has become widespread due to the increased adoption of renewable energy systems, such as rooftop solar panels, which can be easily installed in residential homes. However, because these energy sources often depend on variable conditions (e.g., sunlight), a prosumer's status can shift from seller to buyer. For instance, a prosumer with a photovoltaic system might sell excess energy generated on a sunny day but need to purchase additional energy during nighttime or in less sunny seasons. Without a private energy storage system, this transition from producer to consumer can happen within the same day.

- ***Aggregator in Energy Communities***

The aggregator is a critical operator within the electricity market, responsible for consolidating and managing various production and consumption units into a single, cohesive entity, often represented by an energy community. By aggregating these units, the aggregator enables access to the dispatching services market a platform typically unavailable to individual users or producers.

Besides energy aggregation, the aggregator provides a variety of additional services that extend beyond simply supplying energy. These services include supporting the Transmission System Operator (TSO) by facilitating the operation of the network and aiding the implementation of energy communities. Within the energy community, the aggregator's role can be extensive, encompassing tasks such as integrating diverse users, purchasing necessary electricity from the national market, managing energy and infrastructure within the community, and potentially overseeing the provision of ancillary services to the TSO.

- ***Public Authorities in Energy Communities***

Public authorities play an essential role in enabling and supporting the growth of energy communities (ECs). To facilitate this, the European Commission has established specific directives that require Member States to enact legislation allowing citizens to form and participate in ECs. At the local level, authorities can promote the development of ECs by actively participating as both consumers and producers of energy. Additionally, they can serve as facilitators by providing financial support for the establishment of ECs, thereby acquiring a stake in these communities and gaining decision-making power. [24] [12]

To maintain the non-profit nature of Energy Communities and ensure that their primary objective is to benefit citizens, energy service companies (ESCOs) are not permitted to participate as active members of these communities. However, ESCOs are allowed to provide essential services related to the development and maintenance of energy infrastructure and plants for the members of the Energy Community.

Subject	Action in EC
Consumer	Buyer
Producer	Seller
Prosumer	Buyer and Seller
Public authority	Promoter

Table 1:Summary of the different members and how they can participate in the EC

III.6. Energy Market

III.6.1. Member of the Italian energy sector

The Italian electricity market is directly managed by the Energy Market Operator (Gestore dei Mercati Energetici, GME), under the supervision of the Energy Services Manager (Gestore dei Servizi Energetici, GSE). The market's management is conducted in accordance with the regulations and updates issued by GME and approved by the Ministry of Economic Development, following consultation with the Regulatory Authority for Energy, Networks, and Environment (Autorità di Regolazione per Energia Reti e Ambiente, ARERA).

III.6.2. Regulatory Authority for Energy, Networks, and the Environment (ARERA)

The *Autorità di Regolazione per Energia Reti e Ambiente* (ARERA), also known as the Regulatory Authority for Energy, Networks, and the Environment, was established in 1995 as an independent Italian administrative authority [25]. ARERA's primary function is to promote the development of competitive markets across various sectors, including electricity, natural gas, district heating and cooling, and urban waste management.

The authority fulfils these responsibilities through tariff regulation for network access, monitoring service quality standards, overseeing market operations, and protecting customers and end-users. Notably, ARERA's financing is independent of the state budget, as it is directly funded by the revenues generated from the regulated operators. [26]

III.6.3. Transmission System Operator (TSO)

TERNA is the Transmission System Operator (TSO) responsible for managing and controlling Italy's national electricity transmission grid, which includes high and very high voltage power lines. Established in 1999 as a subsidiary of the energy company ENEL [27], TERNA was later listed on the stock market in 2004. Today, its majority shareholder is the “Cassa Depositi e Prestiti”, an Italian state-controlled investment company. [28]

III.6.4. Distribution System Operator (DSO)

Distribution System Operators (DSOs) are companies responsible for the distribution of electricity, connecting end-users to the transmission network by operating on medium and low voltage lines. In Italy, the electricity distribution system was historically managed under a monopoly by the company "ENEL" until the 1990s. Following policies of liberalization and privatization, multiple DSOs now manage distribution services. These operators purchase electricity on the national electricity market and resell it to their customers in real-time. [29, pp. 11-31]

III.6.5. Energy Services Manager (GSE)

The *Gestore dei Servizi Energetici* (GSE) is an organization controlled by the Italian Ministry of Economy and Finance, operating under the guidance of the Ministry of Ecological Transition. Established in 1999 because of the liberalization of the energy markets [30], GSE now plays a pivotal role in promoting and developing renewable energy sources in Italy. The organization is also tasked with implementing mechanisms to enhance energy efficiency. Beyond the technical and energy management responsibilities, GSE supports institutions in the execution of energy policies and provides specialized services to public administrations in the energy sector. [31]

III.6.6. Energy Markets Manager (GME)

The Italian Energy Markets Manager, known as "*Gestore dei Mercati Energetici*" (GME), is a company under the control of the GSE. Established in its current form in 2004, GME is responsible for the organization and management of the electricity market. It plays a critical role in ensuring the economic management of an adequate power reserve, thereby supporting the stability and efficiency of the Italian energy system. [32]

III.7. Borsa Elettrica

The *Borsa Elettrica* is an organized system for the buying and selling electricity. Introduced in 2004 to facilitate market liberalization in Italy. This system is managed by the Energy Markets Manager (GME) and encompasses the operations necessary for the functioning of the spot electricity market. [33]

IV. The creation of an energy community

The path that leads to the creation of an energy community can ideally be divided into four main steps, which include the active involvement of all members.

- ***Design:*** *This is the step in which the tools and technologies are chosen that align most closely with the configuration of the energy community and its objectives.*
- ***Establishment:*** *The legal form that is best suited to achieving the stated objectives is analysed and chosen. During this phase, the contractual and entity rules are defined that guide corporate governance relations.*
- ***Implementation:*** *this is the step where project for the energy community comes to life. Plants and equipment are built and installed in the designated areas, giving priority to redevelopment of abandoned sited or buildings, and the members of the community receive the metering tools through which they monitor energy production that they manage themselves through the typical contractual forms for projects.*
- ***Management:*** *The energy community is managed by its members, who dictate its internal relationships and those with relevant authorities such as GSE for the purpose of achieving set individual and collective goals, monitoring the flow of the energy produced and incentives and tax benefits when available.*

IV.1. How to meet the proximity requirement needed for the creation of an energy community?

The area occupied by an energy community's plant must be in proximity to the community members, so it is necessary to select land, sites and buildings close to the consumers. This curtails costs and reduces waste related to the distribution of the electricity that is generated and further increases the environmental and economic benefits of the energy community.

IV.2. How do energy communities work?

Following the commissioning of the plant or plants that make up a specific energy community. It is possible to submit a formal application to GSE for the incentives provided assistance from an external company hired for this purpose.

The incentives are not given for all the energy produced but cover only the amount of energy shared and simultaneously consumed by members of the energy community, i.e. only the electricity consumed during the same period in which it was produced. In the event that electricity production exceeds the consumption threshold the community receives a financial sum equal to the coast of the energy in excess, with no further benefits.

Excess electricity can be stored in storage systems, such as electrochemical lithium-ion batteries, to then be used later or during times in the day in which the production from renewable sources is hindered (for example during the night when photovoltaic panels have no sunlight to transform into electricity) or to meet any possible peaks in energy demand.

IV.3. The use of energy communities in the photovoltaic sector

Without a doubt, energy communities that decide to rely on solar energy generation have access to numerous advantages.

Due to their nature, photovoltaic panel system can easily be adapted to both urban and rural settings. For examples, an SMEs "*small and medium-sized enterprises*" or a public administration can facilitate the installation of plants on various types of roofs, such as on factories, public or private buildings, schools, libraries and so on.

In parallel to neighbourhood communities, it is also possible to stablish energy communities in agricultural areas and villages. For example, an agricultural energy community could have row crops next to or alternating with photovoltaic panels on land provided by one or several community members or by a third party.

Thanks to this optimization of space and resources that photovoltaic energy communities are specifically used to meet the unique needs of an area and community by virtue of their hight adaptability to any type of setting.

Furthermore, modern technologies in the photovoltaic sector allow for the systematic use of recycled and recyclable materials in the production of solar panels and plants. Because of this, the materials can be easily salvaged or put to another use at the end of their life, emphasizing "circular economy" principles that are another fundamental pillar for the sustainable development of society.

IV.4. The Network Perimeter

According to current regulations, the withdrawal and injection points of the plants must be primarily located on low voltage electrical networks connected to the same high voltage/medium voltage transformation substation. In this regard, it is the distributor's responsibility to make the perimeter of the transformation substations available to those who request it.

The energy community can only use existing networks and cannot make physical modifications to their configuration, therefore, closed networks are not provided for, as the community's transfers will be regulated through a virtual regulatory mode.

The renewable energy production plants that are part of the energy community must:

- *Have a maximum incentive power of 1 MW*
- *Have come into operation after the effective date of the decree implementing the European directive, without prejudice to the possibility of connection for existing plants, always renewable, for a measure not exceeding 20% of the total power.*
- *Be connected to the same high/medium voltage transformation substation.*
- *Be held by community members: the plants can be owned or managed by a third party, provided that the owner/ manager is subject to the community's instruction.*

The owner does not necessarily have to be holder or produced. as these roles can be represented by different entities:

- *The 'holder' is the individual or entity with full access and control of the plant, based on a legal agreement other than ownership. This may include the right to use and enjoy property owned by someone else, a temporary use agreement, or* *other contractual arrangements that grant usage rights without transferring full ownership.*

- *The "producer" is the entity responsible for operation the plant (holder of the electric plant license and authorizations for operation).*

Some regional laws impose additional limits regarding the minimum consumption of the energy community, or the level community self-consumption achieved and simultaneously offer incentives and funding for the establishment of the communities.

The two regulations, regional and national, currently present some difference in the conception and extension of renewable energy communities, but the imminent implementation of the European directive is expected to smooth out the differences between these two regulations and unify the regulatory framework at the European level.

V. ENERECO_Spa and its projects

V.1. Company Overview

ENERECO. Spa was established in 1994 with the goal of providing specialized services in the energy sector, particularly focusing on renewable energy solutions and environmental sustainability. Over the years, ENERECO. Spa has evolved into a significant player in the energy industry, known for its innovative approaches and commitment to sustainable practices. The company has steadily grown its expertise and expanded its portfolio to include a wide range of energy services, from consultancy and design to implementation and maintenance of energy system.

The mission of ENERECO. Spa is to drive the transition towards sustainable energy by developing and implementing innovative solutions that reduce environmental impact and promote energy efficiency. The company aims to be at the forefront of the renewable energy sector, providing high-quality services and solutions that meet the evolving needs of the market while contributing to the global efforts against climate change. ENERECO_Spa is dedicated to delivering value to its clients, stakeholders, and the wider community through its commitment to sustainability, technological innovation, and excellence in service delivery.

V.2. General Overview of ENERECO_Spa Projects

ENERECO.SPA is a leading company in the renewable energy sector, known for its extensive portfolio of projects that emphasize sustainability and innovation. The company's projects span various types of renewable energy sources and efficiency initiatives, aiming to contribute to the global transition towards a more sustainable energy system. Some ENERECO. Spa's projects:

V.2.1. Solar Power Projects

ENERECO. Spa has developed and constructed numerous large-scale solar power plants across Italy and other regions. These projects significantly contribute to the renewable energy capacity of the areas they serve. The company's solar installations include both photovoltaic PV systems and Solar thermal plants, harnessing solar energy to generate electricity and heat sustainably.

V.2.2. Wind Energy Projects

The company is actively involved in both onshore and offshore wind energy projects. These projects leverage advanced wind turbine technologies to capture wind energy efficiently. ENERECO_Spa's wind farms are designed to provide substantial renewable energy outputs while minimizing environmental impacts.

V.2.3. Hydropower Projects

ENERECO_Spa has executed several hydropower projects that utilize flowing water to generate electricity. These projects include the construction and maintenance of small to medium-size hydroelectric plants, which are crucial for providing stable and clean energy.

V.2.4. Agricultural Photovoltaics

An innovative focus area for ENERECO_Spa is agrivoltaics, where photovoltaic systems are integrated with agricultural activities. This dual-use approach allows for the production of clean energy while maintaining agricultural productivity. These projects contribute to the sustainability of agricultural operations and offer additional revenue streams for farmers.

V.2.5. Energy Efficiency Initiatives

Beyond renewable energy generation, ENERECO_SPA is dedicated to enhancing energy efficiency across various sectors. The company implements projects that focus on reducing energy consumption and improving energy use in industrial, commercial, and residential buildings. These initiatives help lower carbon footprints and reduce energy costs.

V.3. ENERECO_Spa’s Role in Renewable Energy Community

Currently, ENERECO_Spa is embarking on its first project involving Renewable Energy Communities (REC). This groundbreaking initiative aims to establish a Renewable Energy Community in *Sant’ Ippolito*, a municipality in the Province of *Pesaro e Urbino (PU)* within the Marche region of Italy. *Sant’ Ippolito* is strategically located approximately 50 kilometres (31miles) west of *Ancona* and about 25 kilometres (16miles) south of *Pesaro*. More details are provided in the following Table.

Coordinates	*43°41'05.2"N 12°52'15.49"E*
Country	*Italy*
Region	*Marche*
Province	*Pesaro e Urbino (PU)*
Total Area	*19.85km^2*
Elevation	*246m (807 ft)*
Total Population (01/01/2024)	*1465 citizens*
Density	*73.80/km^2*
Postal code	*61040*

Table 2:Detail about Sant ‘Ippolito (Marche)

Sant’ Ippolito is well-positioned to adopt renewable energy sources, particularly solar and wind power. The region benefits from high solar irradiance, making it ideal for solar energy generation, with rooftop solar panels on both residential and public buildings effectively tapping into this resource. Additionally, the community's strong focus on sustainability supports the formation of Renewable Energy Communities (RECs), which empower residents to generate and utilize their own energy, thereby enhancing local energy security and promoting sustainability.

Figure 1:Sant'Ippolito within the Province of Pesaro e Urbino

V.3.1. Climate classification of Sant' Ippolito

the climate classification of Italian municipalities was introduced to regulate the operation and operating periods of building heating systems to reduce energy consumption.

Below is the climate zone for the territory of Sant' Ippolito, assigned by Presidential Decree No.412 of August 26, 1993, and subsequent updates up to October 31, 2009. [34]

Climate Zone **E**	Heating system operation period: from Octobre 15 to Aprile 15 (14 hours per day), unless extended by the mayor.
Degree Days **2,271**	The degree day (DD) of a location is the unit of measurement that estimates the energy requirement necessary to maintain a comfortable Climate in homes. It represents the sum, extended to all days of a conventional annual heating period, of the average daily temperature increments needed to reach the threshold of 20°C The higher the DD value, the greater the need to keep the heating system on.

Table 3:Climate classification of Sant' Ippolito

the table below the different climate zone in Italy, based on degree days, along with the corresponding heating periods and number of daily heating hours allowed for each zone. [34]

Climate Zone	***Degree Days (Gradi-Giorno)***	***Period***	***Number of Hours (Numeri di ore)***
A	*Municipalities with DD≤ 600*	*December 1 - March 15*	*6 hours daily*
B	*600 < municipalities with DD ≤ 900*	*December 1 - March 31*	*8 hours daily*
C	*900 < municipalities with DD ≤ 1,400*	*November 15 - March 31*	*10 hours daily*
D	*1,400<municipalities with DD ≤ 2,100*	*November 1 - April 15*	*12 hours daily*
E	*2,100<municipalities with DD ≤ 3,000*	*October 15 - April 15*	*14 hours daily*
F	*municipalities with DD > 3,000*	*all year round*	*no limitation*

Table 4:Different climate zone in Italy

V.3.2. Impact on photovoltaic plants

The various climate zones in Italy significantly affect photovoltaic (PV) plants due to differing levels of sunlight exposure. Regions with higher degree days (typically cooler areas) often receive less solar irradiance than those with lower degree days (warmer areas), impacting electricity generation potential.

Temperature also plays an important role, higher temperatures can reduce solar panel efficiency. Consequently, PV plants in warmer zones may generate less electricity per panel compared to those in cooler zones. Additionally, plants located in hotter areas may need extra cooling mechanisms to maintain optimal efficiency, which can increase operational costs.

V.3.2.1. Impact on Photovoltaic Plants in Zone E

Saint' Ippolito experiences a moderate to cold climate, characterized by significant seasonal variation. This results in ample sunlight during spring and fall, but reduced efficiency in winter due to shorter days and potential snow coverage. With a long heating period from October to April, there is increased energy demand during the colder months.

Photovoltaic (PV) plants can help offset some of this demand, particularly during the transitional months of October and April when sunlight is more abundant. While PV plants in Zone **E** are expected to perform well in spring and fall, their efficiency may decline in winter due to snow accumulation and shorter daylight hours. Therefore, it is essential to consider energy storage solutions to maximize the utility of solar energy throughout the year.

VI. Project description

VI.1. Technical Description

VI.1.1. Territorial Framework

The installation site is in the municipality of *Sant' Ippolito*, province of *Pesaro_Urbino*(PU) it's a municipality with 1465 inhabitants, belonging to climate zone **E** in Marche Region, it is situated in an area which allows good solar irradiation through the day.

The following table displays the average day lengths for the entire year of 2024 in Sant' Ippolito. [35]

Month	**average length of the day**	**Month**	**average length of the day**
January:	9 hours 46 minutes	**July**	15hours18minutes
February	10 hours 22 minutes	**August**	14 hours 5 minutes
March	11 hours 27 minutes	**September**	12hours31minutes
April	12 hours 50 minutes	**October**	10hours58minutes
May	14 hours 14 minutes	**November**	9 hours 44 minutes
June	15 hours 50 minutes	**December**	9 hours
annual average day length		12 hours 10 minutes	

Table 5:full year of average day lengths. "year2024"

Some relevant climatic data, obtained from **PVGIS-SARAH.com** and derived from the **UNI10349** standard, are provided below. Temperature values are important for estimating consumption and the operating range of photovoltaic modules, while irradiation data are essential for calculating the plant's productivity. [36]

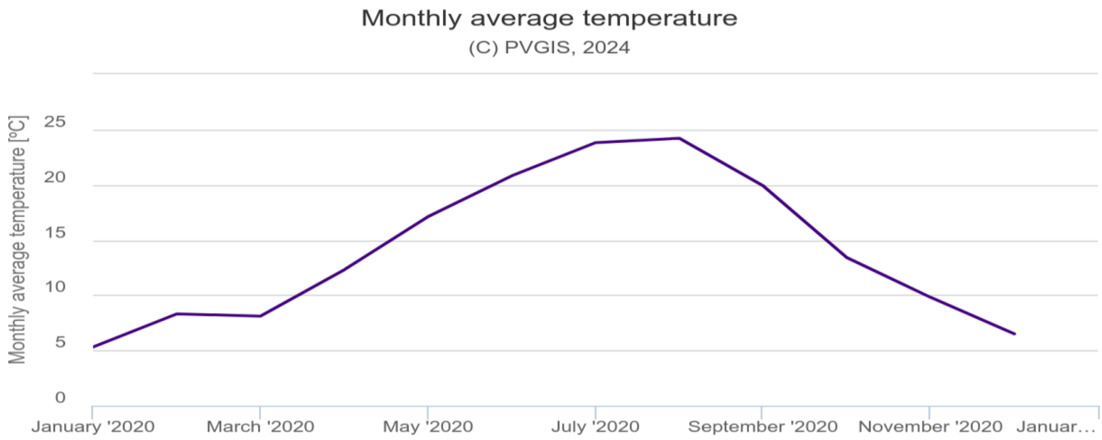


Figure 2:Monthly average temperature2020

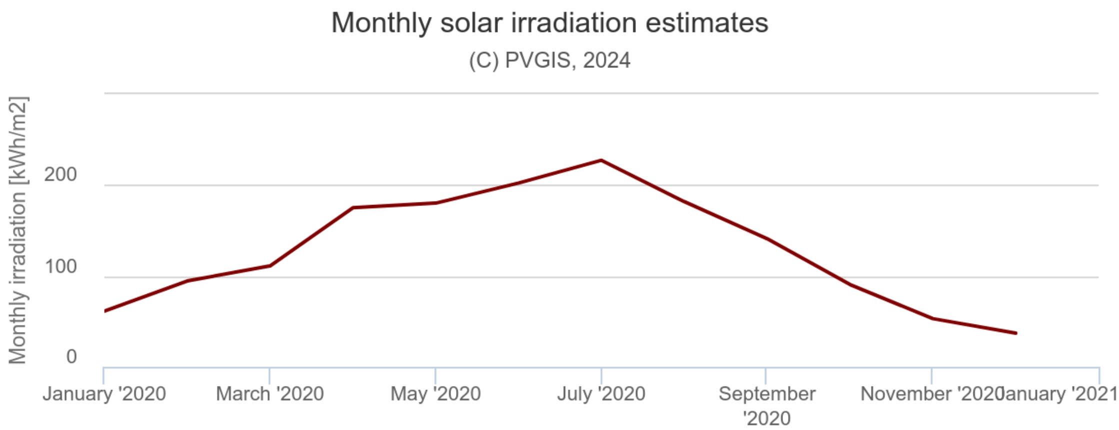


Figure 3:Monthly solar irradiance 2020

VI.1.2. System sizing

The sizing of photovoltaic systems is carried out by considering factors such as:

- *Availability of space*
- *Solar exposure*
- *Morphological and environmental factors such as shading and albedo*
- *Geomorphological and regulatory factors*

The size of the system is usually determined based on the building's internal consumption to maximize physical self-consumption or net metering, while trying to avoid excessive energy production, which is less conveniently compensated. In the case of energy communities, however, this limitation does not apply, as the energy produced can also be consumed by nearby users.

However, since it is not possible to apply the net metering model in this context, it is essential that the hourly consumption of the users within the energy community is always equal to or greater than the amount of energy produced by the systems. Therefore, the sizing of the photovoltaic system aims to maximize self-consumption. In the context of energy communities, this shifts from individual physical self-consumption to community-wide self-consumption.

The chosen system is a Bifacial Double Glass High-Efficiency Mono Module JAM54D40-450/LB, with a weight of 22 kg and dimensions of 1762 ± 2 mm × 1134 ± 2 mm × 30 ± 1 mm. The following table shows the characteristics of the chosen PV module. [37]

Cell	Mono_16BB
Weight	22kg
Dimensions	1762±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm^2(IEC), 12 AWG(UL)
No. of Cells	108(6×18)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-351/ MC4-EVO2A
Cable Length (Including Connector)	Portrait :300mm (+) /400mm (-) ;800mm (+) /800mm (-) (Leapfrog) Landscape: 1200mm (+)/1200mm (-)
Front Glass/Back Glass	1.6mm/1.6mm
Packaging configuration	36pcs/pallet,936pcs/40HQ Container

Table 6:characteristics of the chosen PV module

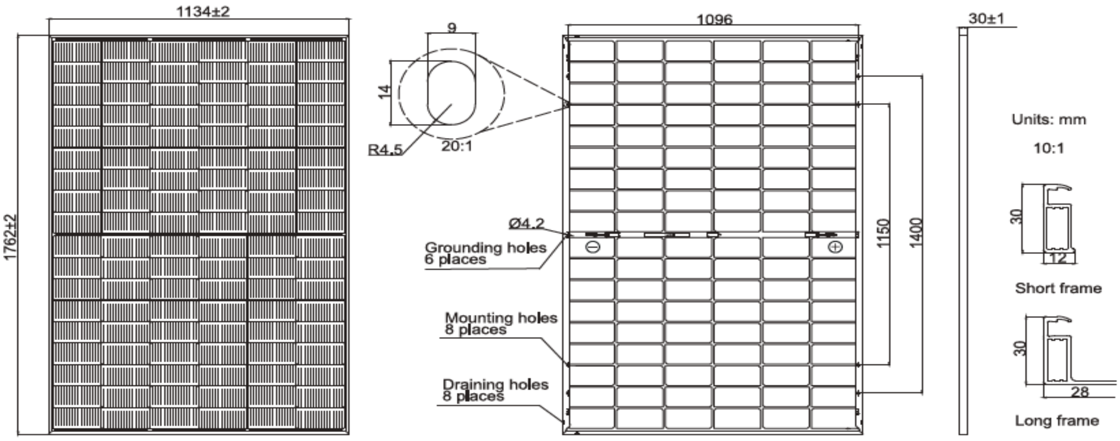


Figure 4:photovoltaic system sizing

The **JAM45D40-450/LB** solar panel is engineered to deliver a robust power output, with a rated maximum capacity of **450 watts** (W). It operates at a maximum power voltage (Vmp) of **32.82 volts** and generates a short-circuit current (Isc) of **14.83 amperes**. Under optimal conditions, the panel can deliver a maximum power current (Imp) of **13.71 amperes.**

This solar panel boasts a high efficiency, with a module efficiency rating of **22.50%,** signifying its effectiveness in converting sunlight into electrical energy. The power tolerance of the panel is rated between 0 to +5W, indicating that it can potentially produce up to 5 watts more than its nominal power output, ensuring no negative deviation from its rated capacity.

Temperature can impact the panel's performance, as reflected by its temperature coefficients:

- **The short-circuit current** (Isc) increases by +0.046% per degree Celsius (°C).
- **The open-circuit voltage** (Voc) decreases by -0.260% per °C.
- **The maximum power output** (Pmax) decreases by -0.300% per °C.

These performance metrics are based on Standard Test Conditions (STC), which involve an irradiance level of **1000 watts** per square meter (W/m²), a cell temperature of **25°C**, and an air mass of **1.5**. These standardized conditions are used to ensure uniformity in performance ratings across various solar panel models and manufacturers. The following table provides a detailed summary of these specifications.

Type	JAM45D40-450/LB
Rated Maximum Power (Pmax)[W]	***450***
Open Circuit Voltage (Voc)[V]	***39.30***
Maximum Power Voltage (Vmp) [V]	***32.82***
Short Circuit Current (Isc) [A]	***14.48***
Maximum Power Current (Imp)[A]	***13.71***
Module Efficiency [%]	***22.5***
Power Tolerance	***0~+5W***
Temperature coefficient of Isc(∝_Isc)	***+0.046%/°C***
Temperature Coefficient of Voc(β_Voc)	***-0.260%/°C***
Temperature Coefficient of Pmax(γ_Pmp)	***-0.300%/°C***
Standard Test Conditions (STC)	***Irradiance 1000W/m^2, cell temperature 25°C, AM1.5G***

Table 7:Electrical parameters at STC

VI.2. System Installation

The photovoltaic system will be installed on two different types of structures. In collaboration with the municipality, the company has decided to use the primary school and the cemetery buildings to support 104 photovoltaic modules. An additional 802 modules will be installed on carports located in various locations. In total, 906 photovoltaic panels will be installed, with an estimated annual energy production of 448.98 Megawatt-hours (MWh).

Using **Google Earth Pro**, the site for installation is first identified, where the azimuth and tilt angles for the photovoltaic (PV) modules are measured. The azimuth angle determines the direction the solar panels will face, while the tilt angle represents the inclination of the panels relative to the horizontal plane. Once these parameters are finalized, the site layout is exported to **AutoCAD DWG Viewer and Editor** for further detailing. This tool helps in creating precise installation plans, ensuring accurate positioning of the solar panels.

Next, **SolarEdge**, a solar design and optimization tool, is employed to input vital data such as the project's location, the number of PV modules, and their inclination. For this installation, the spacing between photovoltaic panels is set to **5cm** between rows and **5cm** between columns, with a minimum height of **2** meters. Additionally, the system specifications are entered, including details about the photovoltaic module, specifically the “J Solar” brand and the “JAM54D40-450” model. After selecting the appropriate inverter and setting the maximum power peak, a system simulation is run to optimize performance and ensure compliance with the project’s requirements.

The simulation provides critical insights, including annual energy production, performance ratio, estimated monthly energy output, a bill of materials, a system loss diagram, and overall system performance. This process ensures that the photovoltaic system will be both efficient and cost-effective, and that it meets the energy needs of the designated areas.

VI.2.1. Roof installation

104 photovoltaic modules will be installed on building roofs. The buildings were selected after considering factors such as roof slope, material, condition (e.g., presence of holes or damage), and overall size. The two chosen buildings are located at the Cemetery and the Primary School.

Sant’ Ippolito Cemetery

A total of 46 photovoltaic (PV) modules have been installed, with a combined annual energy production of 25.01 Megawatt-hours (MWh). These modules provide a total nominal electrical power output of 19.32 kilowatts peak (kWp). The system is designed with modules positioned in two different orientations, which can help optimize energy generation by capturing sunlight from multiple angles throughout the day.

This configuration highlights the versatility of photovoltaic systems in adapting to varying installation conditions to maximize energy yield, even when modules are not uniformly oriented.

Sant' Ippolito Cemetery

Installed DC Power	Annual Energy Production	CO2 Emission Saved (Annually)	Performance Ratio
19.32kwp	25.01mwh	6.4t	89%

PV Module

#Module	Model	Peak power	Orientation	Azimuth	Tilt
20	JA Solar, JAM54D40-450/LB	8.41kwp		141°	5°
26	JA Solar, JAM54D40-450/LB	10.91kwp		141°	5°
Total: 46	19.32kwp				

Indicative layout of the system:

the monthly solar energy production, measured in Megawatt-hours (MWh), over the course of a year. The data shows a clear seasonal variation, with energy generation peaking during the summer months, particularly in May, June, and July, the following chart show the estimated monthly energy

Figure 5:estimated monthly energy of sent' Ippolito cemetery

Month	Solar Production (kWh)
January	846
February	1224
March	2074
April	2600
May	3190
June	3225
July	3503
August	2973
September	2238
Octobre	1499
November	913
December	721

Table 8:monthly solar production in Sant' Ippolito cemetery

Pian Di Rose Primary School

The photovoltaic system installed at Pian-Di-Rose Primary School has a total installed DC power capacity of 26.10kWp. This system is anticipated to generate around 31.93 MWh of electricity annually, leading to a reduction in CO2 emissions by 8.17 tons each year. With a performance ratio of 86%, the system is highly efficient in converting sunlight into usable electricity.

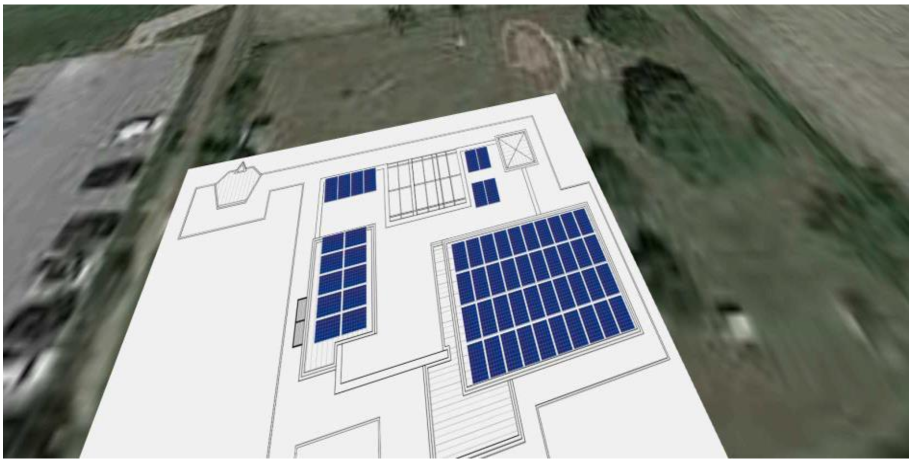
The installation features a total of 58 photovoltaic modules arranged in three different orientations to optimize sunlight capture throughout the day. By varying the orientation and tilt of the panels, the configuration ensures well-balanced energy production, maximizing solar efficiency throughout the year.

This design strategy enhances the overall performance of the photovoltaic system by taking advantage of the different sun angles during the day and across seasons.

Pian Di Rose Primary School			
Installed DC Power	Annual Energy Production	CO2 Emission Saved (Annually)	Performance Ratio
26.10kwp	31.93mwh	8.17t	86%

PV Module						
#Module		Model	Peak power	Orientation	Azimuth	Tilt
8		JA Solar, JAM54D40-450/LB	3.6kwp		168°	5°
40		JA Solar, JAM54D40-450/LB	18kwp		75°	0°
10		JA Solar, JAM54D40-450/LB	4.5kwp		168°	0°
Total:	58	26.1kwp				

Indicative layout of the system:



The following figure illustrates a clear seasonal variation, with energy generation peaking during the summer months, particularly in May, June, and July.

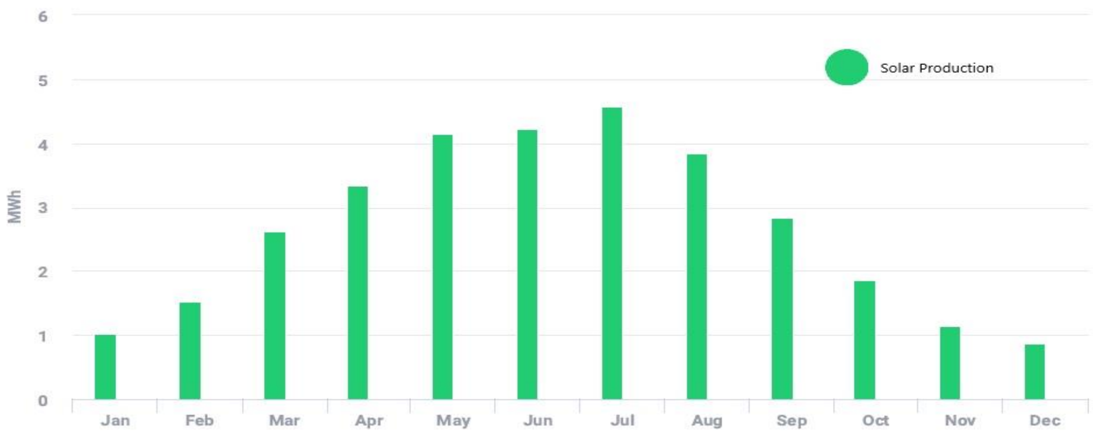


Figure 6:estimated monthly energy of Pian Di Rose Primary School

Month	Solar Production (kWh)
January	1022
February	1526
March	2624
April	3331
May	4139
June	4203
July	4554
August	3831
September	2831
Octobre	1864
November	1128
December	873

Table 9:monthly solar production in Pian Di Rose Primary School

VI.2.2. Carports

The idea of installing carports as support structures for photovoltaic plants, while also providing sun protection and added comfort for parking users, was initiated by Doctor.*Davide Barbaresi*. These carports feature an extremely versatile structure capable of accommodating photovoltaic panels of any type. The design follows a precisely optimized static scheme that allows the canopy to achieve high performance standards, using profiles with minimal cross-sections to create an elegant and minimal aesthetic. Ground anchoring is achieved through above-ground reinforced concrete ballasts, which do not require the preparation of foundations. This significantly reduces the time and costs necessary for installation. Three types of carports (Type A, Type B, and Type C) were selected, depending on the number of photovoltaic modules used at the site. The following images provide example of a carport installed in a parking area.

Figure 7: Example of a carport installed in a parking area.

Figure 8: Example of a carport installed in a parking area.

Technical specifications

- ***Carport-Type A***

Three different carport types were selected for the installation, based on the number of photovoltaic (PV) modules that each site could accommodate. *Carport Type A* is the largest, with a structure length of 47 meters, designed to support PV modules across a total length of 44.894 meters. The modules are arranged in three rows, accommodating 117 PV modules (39 columns x 3 rows). The total system capacity for this carport is 52.65kWp, and it provides **17** parking spaces. [37]

- ***Carport - Type B***

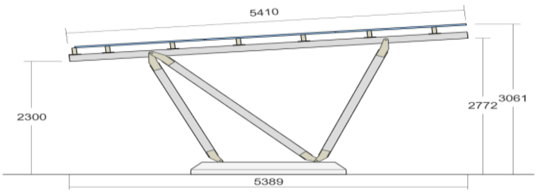
Carport Type B, have a structure length of 27.500 meters, designed to support PV modules across a total length of 26.494 meters. The modules are arranged in three rows, accommodating 69 PV modules (23 columns x 3 rows). The total system capacity for this carport is 31.05kWp, and it provides **10** parking spaces. [37]

- ***Carport - Type C***

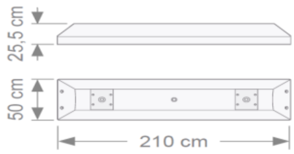
Carport Type C, have a structure length of 41.500 meters, designed to support PV modules across a total length of 41.444 meters. The modules are arranged in three rows, accommodating 108 PV modules (36 columns x 3 rows). The total system capacity for this carport is 48.60kWp, and it provides 15 parking spaces. [37]

Carport-Type A

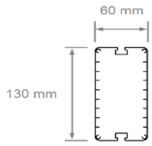
Side view

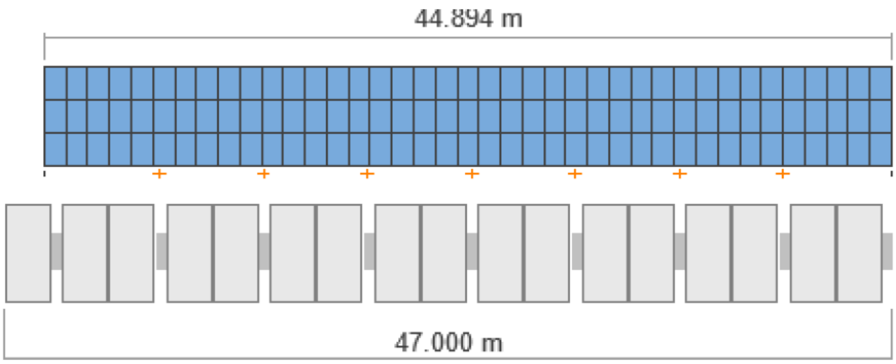


Reinforced concrete ballast - 500kg



Profile (Aluminium)

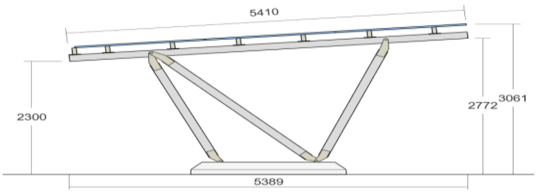




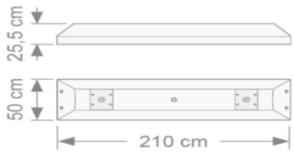
Structure Data	
Photovoltaic panel size	1762 × 1134 × 30 mm 450 W
Panel layout	Vertical
Number of panels	117 (39 columns x 3 rows)
Total system power	52.65kwp
Useful height	2.300 m
Inclination	5.0°
Maximum height	3.060m
Coverage depth	5.410m
Ballast centre distance	5.500m
Parking space width	2.500m
Number of parking spaces	17
Total structure width	44.894m
Structure Colour	Silver Anodized

Carport - Type B

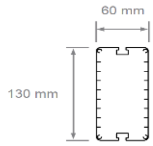
Side view

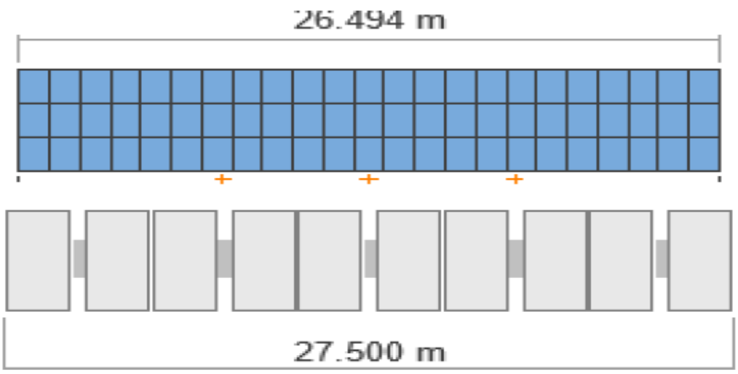


Reinforced concrete ballast - 500kg



Profile (Aluminium)

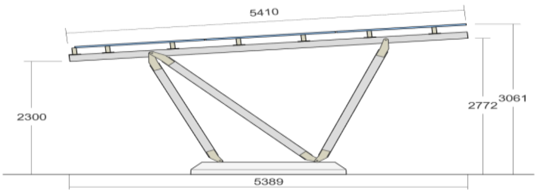




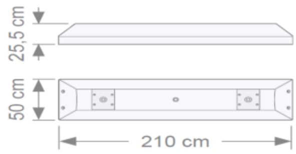
Structure Data	
Photovoltaic panel size	1762 × 1134 × 30 mm 450 W
Panel layout	Vertical
Number of panels	69 (23 columns x 3 rows)
Total system power	31.05kwp
Useful height	2.300 m
Inclination	5.0°
Maximum height	3.060m
Coverage depth	5.410m
Ballast centre distance	5.500m
Parking space width	2.500m
Number of parking spaces	10
Total structure width	26.494m
Structure Colour	Silver Anodized

Carport - Type C

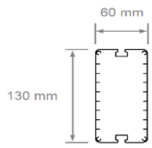
Side view

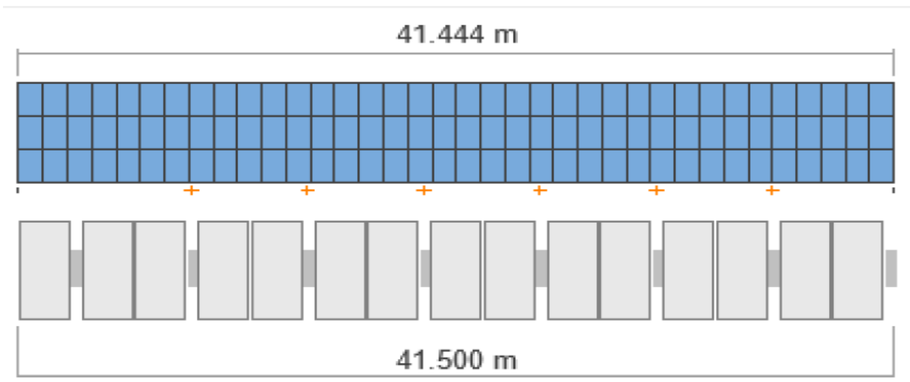


Reinforced concrete ballast - 500kg



Profile (Aluminium)





Structure Data

Photovoltaic panel size	1762 × 1134 × 30 mm 450 W
Panel layout	Vertical
Number of panels	108 (36 columns x 3 rows)
Total system power	48.60kwp
Useful height	2.300 m
Inclination	5.0°
Maximum height	3.060m
Coverage depth	5.410m
Ballast centre distance	5.500m
Parking space width	2.500m
Number of parking spaces	15
Total structure width	41.444m
Structure Colour	Silver Anodized

VI.2.3. Carport installation

738 photovoltaic modules will be installed on Carports.as support four lot was choosing as typical area for the installation of the carports after a study of the territory and an agreement with the municipality. The area choosing as following.

Pian Di Rose Primary School Parking

The photovoltaic system installed at Sant' Ippolito Pian Di Rose in Primary School Parking has a total installed DC power capacity of 79.65kWp. The system is expected to generate approximately 85.39 MWh of electricity annually, contributing to a significant reduction in CO_2 emissions, with an estimated savings of 21.86 tons per year. With a performance ratio of 78%. The installation consists of 171 photovoltaic modules

<table>
<tr><th colspan="6">Pian Di Rose Primary School Parking</th></tr>
<tr><td>Installed DC Power</td><td>Annual Energy Production</td><td colspan="2">CO2 Emission Saved (Annually)</td><td colspan="2">Performance Ratio</td></tr>
<tr><td>79.65kwp</td><td>85.39mwh</td><td colspan="2">21.86t</td><td colspan="2">78%</td></tr>
<tr><th colspan="6">PV Module</th></tr>
<tr><td>#Module</td><td>Model</td><td>Peak power</td><td>Orientation</td><td>Azimuth</td><td>Tilt</td></tr>
<tr><td>171</td><td>JA Solar, JAM54D40-450/LB</td><td>79.65kwp</td><td></td><td>257°</td><td>5°</td></tr>
<tr><td>Total: 171</td><td colspan="5">79.65kwp</td></tr>
<tr><td colspan="6">Indicative layout of the system</td></tr>
</table>

The following figure illustrates a clear seasonal variation, with energy generation peaking during the summer months, particularly in May, June, and July.

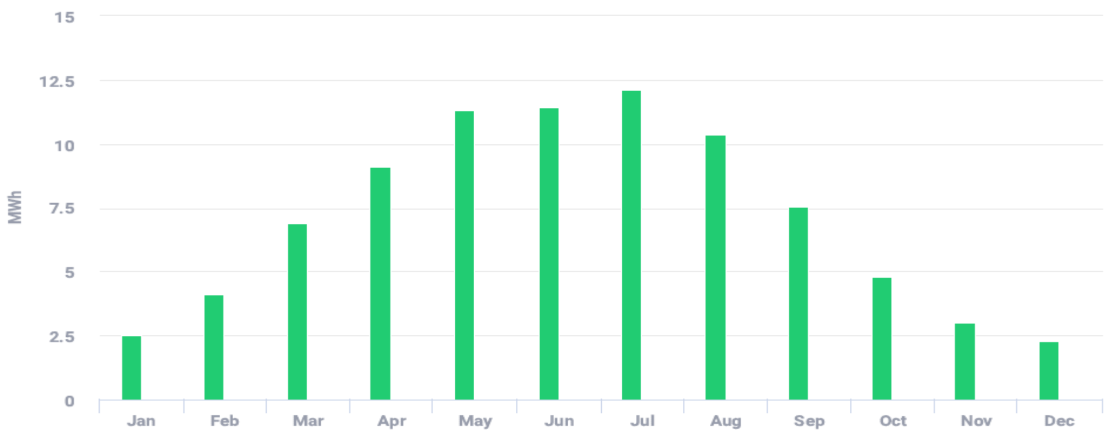


Figure 9:estimated monthly energy of Pian Di Rose Primary School Parking

Month	Solar Production (kWh)
January	2531
February	4099
March	6858
April	9112
May	11380
June	11380
July	12126
August	10377
September	7534
Octobre	4800
November	2997
December	2273

Table 10:monthly solar production in Pian Di Rose Primary School Parking

Shopping centre San. Vincenzo Parking

The photovoltaic system installed at shopping centre San. Vincenzo Parking has a total installed DC power capacity of 126.9kwp. The system is expected to generate approximately 130.93mwh of electricity annually, contributing to a significant reduction in CO2 emissions, with an estimated savings of 33.52 tons per year. With a performance ratio of 74%, the system demonstrates high efficiency in converting sunlight into usable electricity. The installation consists of 282 photovoltaic modules.

<table>
<tr><th colspan="7">shopping centre San. Vincenzo Parking</th></tr>
<tr><td colspan="2">Installed DC Power</td><td colspan="2">Annual Energy Production</td><td>CO2 Emission Saved (Annually)</td><td colspan="2">Performance Ratio</td></tr>
<tr><td colspan="2">126.9kwp</td><td colspan="2">130.93mwh</td><td>33.52t</td><td colspan="2">74%</td></tr>
<tr><th colspan="7">PV Module</th></tr>
<tr><td colspan="2">#Module</td><td>Model</td><td>Peak power</td><td>Orientation</td><td>Azimuth</td><td>Tilt</td></tr>
<tr><td colspan="2">282</td><td>JA Solar, JAM54D40-450/LB</td><td>126.9kwp</td><td></td><td>176°</td><td>5°</td></tr>
<tr><td>Total:</td><td>282</td><td colspan="5">126.9kwp</td></tr>
<tr><td colspan="7">Indicative layout of the system</td></tr>
</table>

The following figure illustrates a clear seasonal variation, with energy generation peaking during the summer months, particularly in May, June, and July.

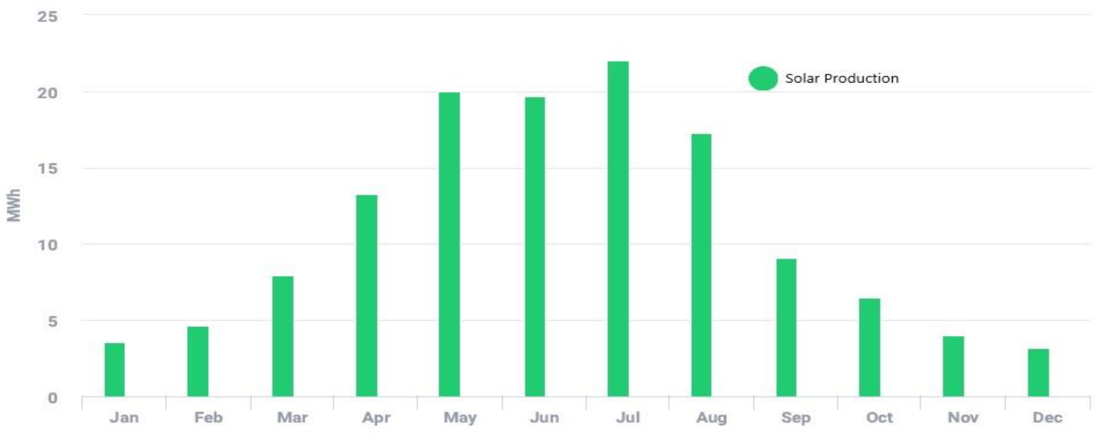


Figure 10:estimated monthly energy of shopping centre San. Vincenzo Parking

Month	Solar Production (kWh)
January	3550
February	4609
March	7933
April	13246
May	19980
June	19675
July	22005
August	17252
September	9053
Octobre	6445
November	3993
December	3188

Table 11:monthly solar production in shopping centre San. Vincenzo Parking

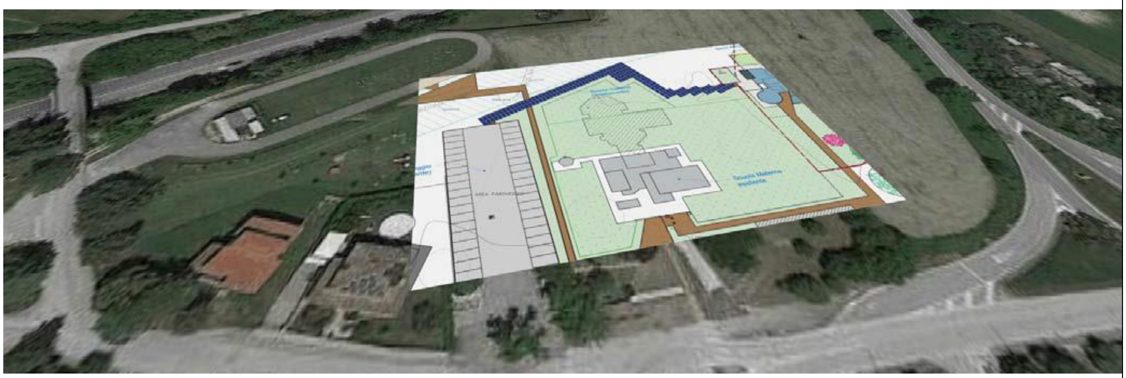
Pian di rose school walkway

The photovoltaic system installed at Pian di rose school walkway has a total installed DC power capacity of 73.35kWp. The system is expected to generate approximately 81.72 MWh of electricity annually, contributing to a significant reduction in CO_2 emissions, with an estimated savings of 20.92 tons per year. With a performance ratio of 76%. The installation consists of 163 photovoltaic modules.

Pian di rose school walkway			
Installed DC Power	Annual Energy Production	CO2 Emission Saved (Annually)	Performance Ratio
73.35kwp	81.72mwh	20.92t	76%

PV Module					
#Module	Model	Peak power	Orientation	Azimuth	Tilt
163	JA Solar, JAM54D40-450/LB	73.35wp		144°	5°
Total: 163	73.35kwp				

Indicative layout of the system



The following figure illustrates a clear seasonal variation, with energy generation peaking during the summer months, particularly in May, June, and July.

Figure 11:estimated monthly energy of Pian di rose school walkway

Month	**Solar Production (kWh)**
January	2020
February	3355
March	6343
April	8766
May	11320
June	11730
July	12649
August	10105
September	7025
Octobre	4150
November	2434
December	1825

Table 12:monthly solar production in Pian di rose school walkway

Sant Ippolito Evolution Camp

The photovoltaic system installed at Sant’ Ippolito *Evolution Camp* has a total installed DC power capacity of 83.70kwp. The system is expected to generate approximately 94.00mwh of electricity annually, contributing to a significant reduction in CO_2 emissions, with an estimated savings of 24.06 tons per year. With a performance ratio of 79%. The installation consists of 186 photovoltaic modules.

Sant Ippolito Evolution Camp

Installed DC Power	Annual Energy Production	CO2 Emission Saved (Annually)	Performance Ratio
83.70kwp	94.00mwh	24.06t	79%

PV Module

#Module	Model	Peak power	Orientation	Azimuth	Tilt
186	JA Solar, JAM54D40-450/LB	83.7kwp		252°	5°
Total: 186		83.7kwp			

Indicative layout of the system

The following figure illustrates a clear seasonal variation, with energy generation peaking during the summer months, particularly in May, June, and July.

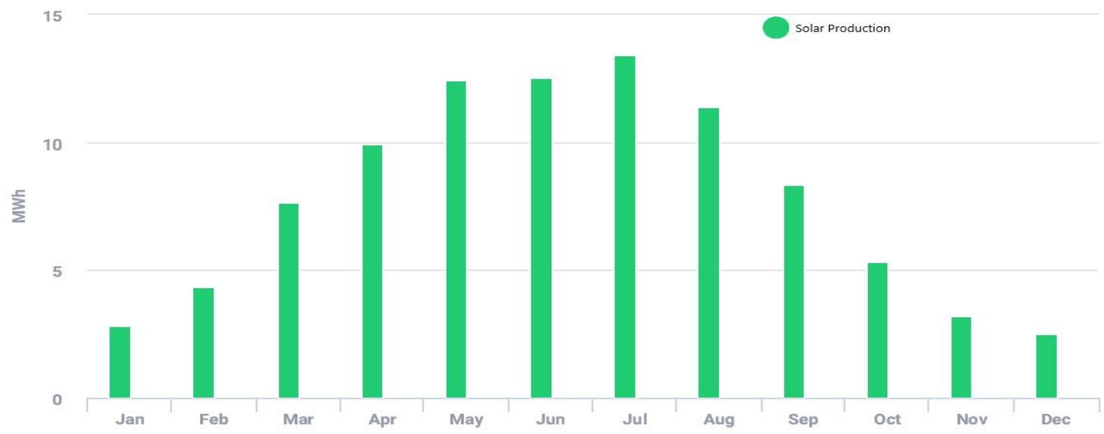


Figure 12:estimated monthly energy of sent' Ippolito, Evolution Camp

Month	Solar Production (kWh)
January	2856
February	4373
March	7614
April	9911
May	12454
June	12570
July	13403
August	11395
September	8360
Octobre	5351
November	3192
December	2524

Table 13:monthly solar production in Sant' Ippolito, Evolution Camp

To enhance clarity and understanding, the community plans to adopt 842 photovoltaic modules across two types of structures (building roofs and carports) at four different locations. Using SolarEdge, we have estimated an annual energy production of 392.6 Megawatt-hours (MWh).

VI.3. Solare

An Excel program is employed to input key project details such as location, PV module count, azimuth and tilt angles, photovoltaic system type, nominal electric power, and other critical parameters. After running the simulation, it provides detailed insights, including daily, monthly, and yearly energy production, alongside a comprehensive 25year energy production forecast, critical for long-term planning. The primary reason for using this program is to gather detailed data and compare the results with SolarEdge, a solar design and optimization tool previously used for system analysis. The following section discusses the results in detail.

VI.3.1. Roof

The following section presents detailed results from the energy production analysis. The first image showcases an Excel table that outlines daily and monthly energy production throughout the year, segmented by hour of the day.

The data is displayed in kilowatt-hours (kWh), with brighter colours indicating higher energy generation during midday, particularly in the summer months. The accompanying charts illustrate both daily and monthly production patterns, while the final image provides a comprehensive overview of the photovoltaic module’s 25-year energy output.

Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso													
ora del giorno	gennaio	febbraio	marzo	aprile	maggio	giugno	luglio	agosto	settembre	ottobre	novembre	dicembre	Media
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,08	1,36	2,30	1,83	0,44	0,00	0,00	0,00	0,00	0,50
6,00	0,00	0,00	0,39	2,28	3,80	4,47	4,37	2,96	0,90	0,00	0,00	0,00	1,60
7,00	0,00	0,74	2,49	4,39	5,76	6,37	6,71	5,39	3,32	1,25	0,15	0,00	3,05
8,00	1,16	2,30	4,11	6,00	7,24	7,80	8,55	7,35	5,22	3,06	1,50	0,85	4,59
9,00	1,87	3,16	5,18	7,17	8,42	8,99	10,07	8,88	6,55	4,20	2,41	1,76	5,72
10,00	2,24	3,71	5,98	8,10	9,37	9,94	11,29	10,10	7,60	5,01	2,94	2,21	6,54
11,00	2,48	4,09	6,53	8,73	10,02	10,58	12,12	10,93	8,31	5,56	3,30	2,49	7,09
12,00	2,59	4,26	6,78	9,02	10,31	10,88	12,50	11,31	8,64	5,81	3,47	2,62	7,35
13,00	2,56	4,22	6,73	8,96	10,24	10,81	12,41	11,22	8,56	5,75	3,43	2,59	7,29
14,00	2,40	3,97	6,36	8,53	9,81	10,38	11,85	10,66	8,09	5,38	3,19	2,40	6,92
15,00	2,10	3,52	5,71	7,78	9,05	9,61	10,87	9,68	7,24	4,73	2,75	2,04	6,26
16,00	1,35	2,71	4,75	6,75	8,00	8,56	9,53	8,33	6,05	3,68	1,84	1,01	5,21
17,00	0,00	0,89	3,07	5,17	6,59	7,21	7,79	6,44	4,14	1,61	0,16	0,00	3,59
18,00	0,00	0,00	0,48	2,86	4,54	5,25	5,35	3,82	1,21	0,00	0,00	0,00	1,96
19,00	0,00	0,00	0,00	0,10	1,71	2,83	2,42	0,61	0,00	0,00	0,00	0,00	0,64
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	18,75	33,56	58,55	85,93	106,23	115,99	127,66	108,11	75,85	46,05	25,14	17,98	
controllo	18,75	33,56	58,55	85,93	106,23	115,99	127,66	108,11	75,85	46,05	25,14	17,98	Tot anno
Tot mese	581,37	939,67	1 815,02	2 577,76	3 293,09	3 479,75	3 957,37	3 351,46	2 275,58	1 427,40	754,31	557,23	25 010,00

Figure 13:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

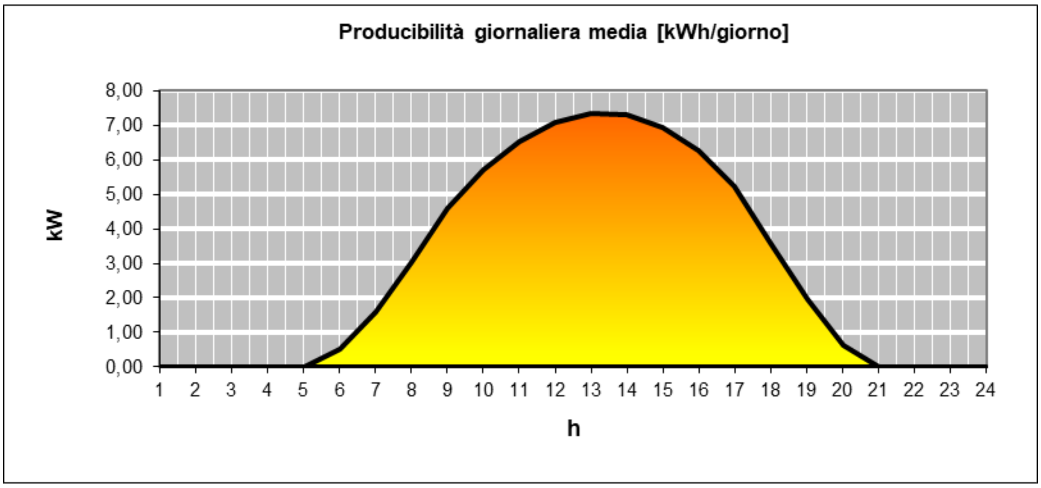


Figure 14:Daily Energy Production

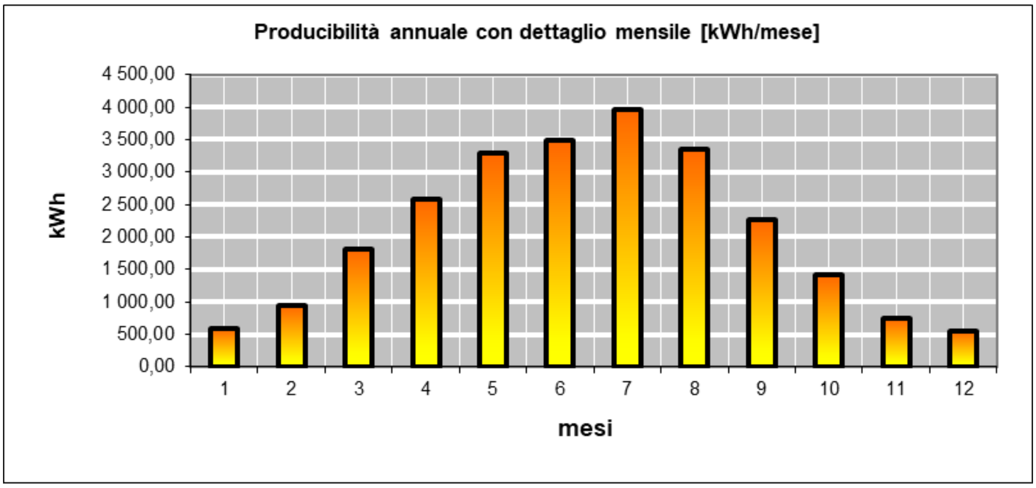


Figure 15:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	**Producibilità**	**Consumi**	**Consumi - giorno**	**Consumo - notte**	**Iniezione in rete**	**Copertura consumi**	**Prelievo dalla rete**	**Iniezione maggiorata**
1	25 010,00	0,00	0,00	0,00	25 010,00	0,00	0,00	25 010,00
2	24 909,96	0,00	0,00	0,00	24 909,96	0,00	0,00	24 909,96
3	24 810,32	0,00	0,00	0,00	24 810,32	0,00	0,00	24 810,32
4	24 711,08	0,00	0,00	0,00	24 711,08	0,00	0,00	24 711,08
5	24 612,23	0,00	0,00	0,00	24 612,23	0,00	0,00	24 612,23
6	24 513,79	0,00	0,00	0,00	24 513,79	0,00	0,00	24 513,79
7	24 415,73	0,00	0,00	0,00	24 415,73	0,00	0,00	24 415,73
8	24 318,07	0,00	0,00	0,00	24 318,07	0,00	0,00	24 318,07
9	24 220,80	0,00	0,00	0,00	24 220,80	0,00	0,00	24 220,80
10	24 123,91	0,00	0,00	0,00	24 123,91	0,00	0,00	24 123,91
11	24 027,42	0,00	0,00	0,00	24 027,42	0,00	0,00	24 027,42
12	23 931,31	0,00	0,00	0,00	23 931,31	0,00	0,00	23 931,31
13	23 835,58	0,00	0,00	0,00	23 835,58	0,00	0,00	23 835,58
14	23 740,24	0,00	0,00	0,00	23 740,24	0,00	0,00	23 740,24
15	23 645,28	0,00	0,00	0,00	23 645,28	0,00	0,00	23 645,28
16	23 550,70	0,00	0,00	0,00	23 550,70	0,00	0,00	23 550,70
17	23 456,49	0,00	0,00	0,00	23 456,49	0,00	0,00	23 456,49
18	23 362,67	0,00	0,00	0,00	23 362,67	0,00	0,00	23 362,67
19	23 269,22	0,00	0,00	0,00	23 269,22	0,00	0,00	23 269,22
20	23 176,14	0,00	0,00	0,00	23 176,14	0,00	0,00	23 176,14
21	23 083,44	0,00	0,00	0,00	23 083,44	0,00	0,00	23 083,44
22	22 991,10	0,00	0,00	0,00	22 991,10	0,00	0,00	22 991,10
23	22 899,14	0,00	0,00	0,00	22 899,14	0,00	0,00	22 899,14
24	22 807,54	0,00	0,00	0,00	22 807,54	0,00	0,00	22 807,54
25	22 716,31	0,00	0,00	0,00	22 716,31	0,00	0,00	22 716,31
Tot	**596 138,46**	**0,00**	**0,00**	**0,00**	**596 138,46**	**0,00**	**0,00**	**596 138,46**
				Controllo	596 138,46			

Figure 16:energy production over 25 years

Pian Di Rose primary school

1. Sant' Ippolito Pian Di Rose primary school(08_Module)

Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso													
ora del giorno	gennaio	febbraio	marzo	aprile	maggio	giugno	luglio	agosto	settembre	ottobre	novembre	dicembre	Media
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,01	0,27	0,45	0,37	0,09	0,00	0,00	0,00	0,00	0,10
6,00	0,00	0,00	0,07	0,44	0,72	0,85	0,84	0,58	0,18	0,00	0,00	0,00	0,31
7,00	0,00	0,14	0,47	0,82	1,07	1,18	1,26	1,02	0,63	0,24	0,03	0,00	0,57
8,00	0,21	0,43	0,76	1,10	1,33	1,43	1,57	1,36	0,97	0,57	0,28	0,15	0,85
9,00	0,34	0,57	0,94	1,30	1,53	1,63	1,83	1,61	1,19	0,76	0,44	0,32	1,04
10,00	0,40	0,66	1,07	1,45	1,68	1,78	2,03	1,81	1,36	0,89	0,52	0,39	1,17
11,00	0,44	0,72	1,15	1,55	1,78	1,88	2,16	1,94	1,47	0,98	0,58	0,44	1,26
12,00	0,45	0,74	1,19	1,59	1,82	1,92	2,21	1,99	1,51	1,01	0,60	0,45	1,29
13,00	0,44	0,73	1,17	1,56	1,79	1,90	2,17	1,96	1,49	0,99	0,59	0,44	1,27
14,00	0,41	0,68	1,09	1,48	1,71	1,81	2,06	1,84	1,39	0,92	0,54	0,40	1,19
15,00	0,35	0,59	0,97	1,33	1,56	1,66	1,88	1,66	1,23	0,79	0,46	0,34	1,07
16,00	0,22	0,45	0,80	1,15	1,37	1,47	1,63	1,41	1,01	0,61	0,30	0,16	0,88
17,00	0,00	0,15	0,51	0,87	1,12	1,23	1,32	1,08	0,68	0,26	0,03	0,00	0,60
18,00	0,00	0,00	0,08	0,47	0,77	0,89	0,90	0,63	0,20	0,00	0,00	0,00	0,33
19,00	0,00	0,00	0,00	0,02	0,29	0,48	0,40	0,10	0,00	0,00	0,00	0,00	0,11
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	3,25	5,84	10,26	15,15	18,81	20,57	22,62	19,08	13,31	8,02	4,35	3,10	
controllo	3,25	5,84	10,26	15,15	18,81	20,57	22,62	19,08	13,31	8,02	4,35	3,10	Tot anno
Tot mese	100,84	163,66	317,95	454,40	582,96	617,09	701,17	591,58	399,26	248,54	130,54	96,14	4 404,14

Figure 17:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

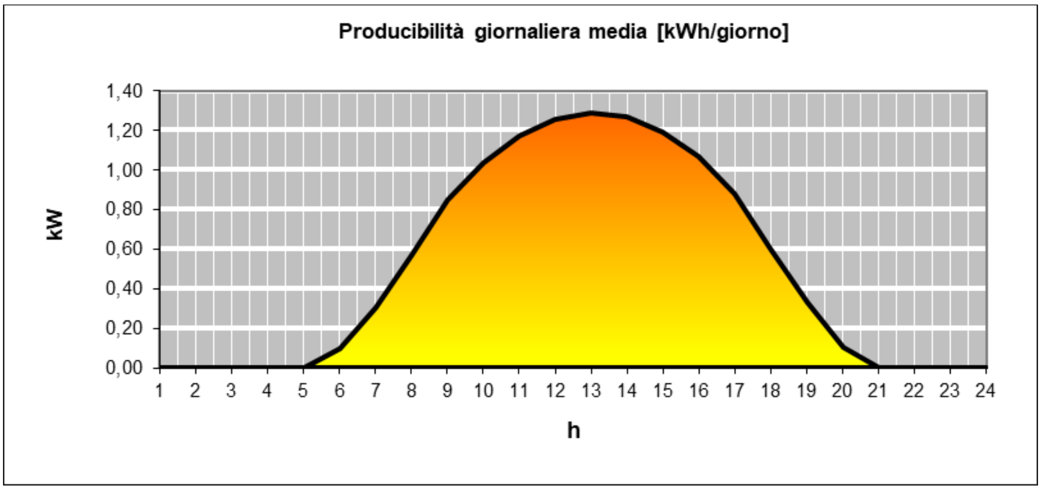


Figure 18:Daily Energy Production

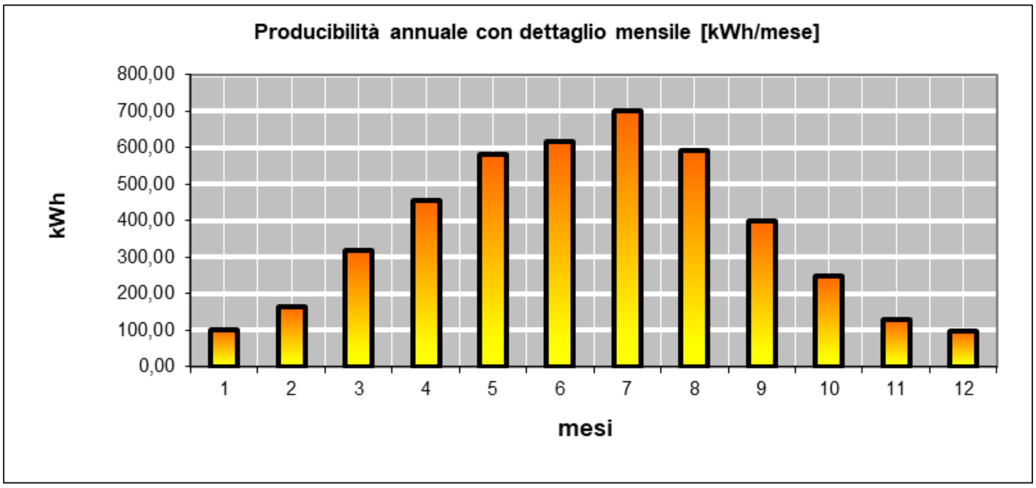


Figure 19:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

Anno	[kWh] Producibilità	[kWh] Consumi	[kWh] Consumi - giorno	[kWh] Consumo - notte	[kWh] Iniezione in rete	[kWh] Copertura consumi	[kWh] Prelievo dalla rete	[kWh] Iniezione maggiorata
1	4 404,14	0,00	0,00	0,00	4 404,14	0,00	0,00	4 404,14
2	4 386,52	0,00	0,00	0,00	4 386,52	0,00	0,00	4 386,52
3	4 368,98	0,00	0,00	0,00	4 368,98	0,00	0,00	4 368,98
4	4 351,50	0,00	0,00	0,00	4 351,50	0,00	0,00	4 351,50
5	4 334,09	0,00	0,00	0,00	4 334,09	0,00	0,00	4 334,09
6	4 316,76	0,00	0,00	0,00	4 316,76	0,00	0,00	4 316,76
7	4 299,49	0,00	0,00	0,00	4 299,49	0,00	0,00	4 299,49
8	4 282,29	0,00	0,00	0,00	4 282,29	0,00	0,00	4 282,29
9	4 265,16	0,00	0,00	0,00	4 265,16	0,00	0,00	4 265,16
10	4 248,10	0,00	0,00	0,00	4 248,10	0,00	0,00	4 248,10
11	4 231,11	0,00	0,00	0,00	4 231,11	0,00	0,00	4 231,11
12	4 214,19	0,00	0,00	0,00	4 214,19	0,00	0,00	4 214,19
13	4 197,33	0,00	0,00	0,00	4 197,33	0,00	0,00	4 197,33
14	4 180,54	0,00	0,00	0,00	4 180,54	0,00	0,00	4 180,54
15	4 163,82	0,00	0,00	0,00	4 163,82	0,00	0,00	4 163,82
16	4 147,16	0,00	0,00	0,00	4 147,16	0,00	0,00	4 147,16
17	4 130,57	0,00	0,00	0,00	4 130,57	0,00	0,00	4 130,57
18	4 114,05	0,00	0,00	0,00	4 114,05	0,00	0,00	4 114,05
19	4 097,59	0,00	0,00	0,00	4 097,59	0,00	0,00	4 097,59
20	4 081,20	0,00	0,00	0,00	4 081,20	0,00	0,00	4 081,20
21	4 064,88	0,00	0,00	0,00	4 064,88	0,00	0,00	4 064,88
22	4 048,62	0,00	0,00	0,00	4 048,62	0,00	0,00	4 048,62
23	4 032,43	0,00	0,00	0,00	4 032,43	0,00	0,00	4 032,43
24	4 016,30	0,00	0,00	0,00	4 016,30	0,00	0,00	4 016,30
25	4 000,23	0,00	0,00	0,00	4 000,23	0,00	0,00	4 000,23
Tot	**104 977,05**	**0,00**	**0,00**	**0,00**	**104 977,05**	**0,00**	**0,00**	**104 977,05**
				Controllo	104 977,05			

Figure 20:energy production over 25 years

2. *pian Di Rose primary school(10_Module)*

	Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso												
ora del giorno	gennaio	febbraio	marzo	aprile	maggio	giugno	luglio	agosto	settembre	ottobre	novembre	dicembre	Media
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,02	0,31	0,51	0,42	0,10	0,00	0,00	0,00	0,00	0,11
6,00	0,00	0,00	0,09	0,54	0,87	1,01	1,00	0,71	0,22	0,00	0,00	0,00	0,37
7,00	0,00	0,18	0,61	1,03	1,32	1,44	1,54	1,27	0,82	0,32	0,03	0,00	0,71
8,00	0,29	0,57	0,99	1,39	1,64	1,76	1,95	1,71	1,25	0,77	0,39	0,22	1,08
9,00	0,46	0,76	1,22	1,64	1,90	2,01	2,27	2,04	1,54	1,02	0,60	0,45	1,33
10,00	0,54	0,88	1,39	1,84	2,10	2,21	2,53	2,29	1,76	1,19	0,71	0,54	1,50
11,00	0,58	0,95	1,49	1,96	2,22	2,33	2,68	2,45	1,89	1,29	0,78	0,60	1,60
12,00	0,60	0,97	1,53	2,00	2,26	2,38	2,74	2,50	1,94	1,33	0,81	0,62	1,64
13,00	0,58	0,95	1,49	1,96	2,22	2,33	2,68	2,45	1,89	1,29	0,78	0,60	1,60
14,00	0,54	0,88	1,39	1,84	2,10	2,21	2,53	2,29	1,76	1,19	0,71	0,54	1,50
15,00	0,46	0,76	1,22	1,64	1,90	2,01	2,27	2,04	1,54	1,02	0,60	0,45	1,33
16,00	0,29	0,57	0,99	1,39	1,64	1,76	1,95	1,71	1,25	0,77	0,39	0,22	1,08
17,00	0,00	0,18	0,61	1,03	1,32	1,44	1,54	1,27	0,82	0,32	0,03	0,00	0,71
18,00	0,00	0,00	0,09	0,54	0,87	1,01	1,00	0,71	0,22	0,00	0,00	0,00	0,37
19,00	0,00	0,00	0,00	0,02	0,31	0,51	0,42	0,10	0,00	0,00	0,00	0,00	0,11
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	4,33	7,65	13,11	18,85	22,97	24,92	27,52	23,62	16,90	10,51	5,85	4,23	
controllo	4,33	7,65	13,11	18,85	22,97	24,92	27,52	23,62	16,90	10,51	5,85	4,23	Tot anno
Tot mese	134,36	214,26	406,43	565,59	712,09	747,62	853,16	732,24	507,08	325,81	175,53	131,00	5 505,17

Figure 21:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

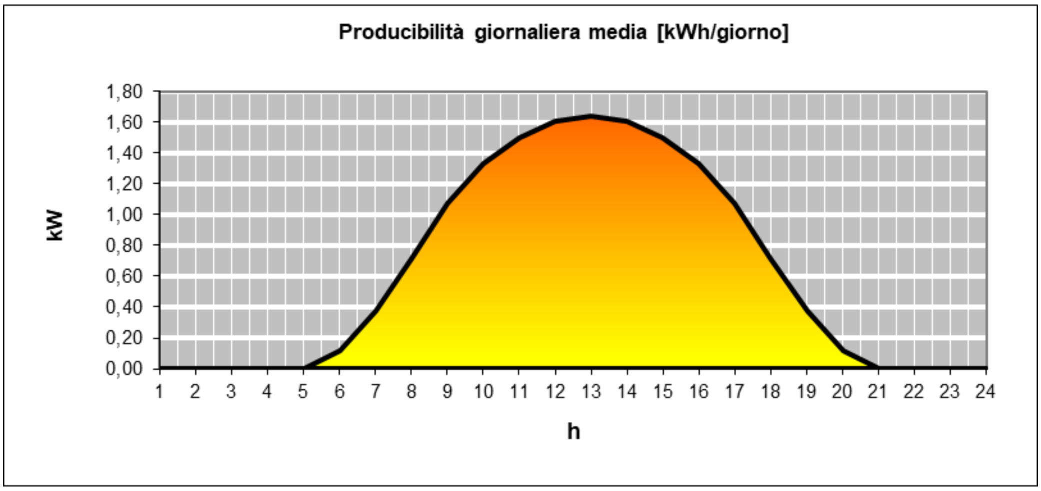


Figure 22:Daily Energy Production

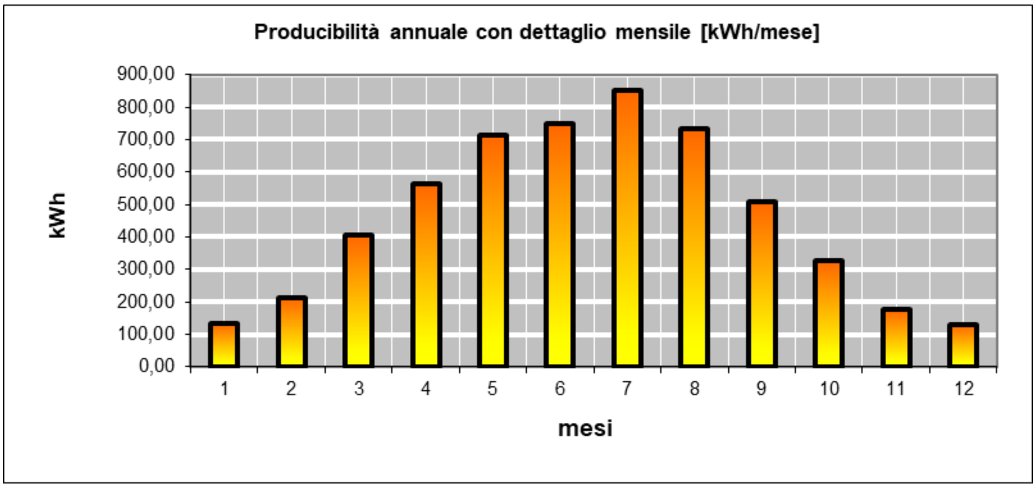


Figure 23:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	Producibilità	Consumi	Consumi - giorno	Consumo - notte	Iniezione in rete	Copertura consumi	Prelievo dalla rete	Iniezione maggiorata
1	5 505,17	0,00	0,00	0,00	5 505,17	0,00	0,00	5 505,17
2	5 483,15	0,00	0,00	0,00	5 483,15	0,00	0,00	5 483,15
3	5 461,22	0,00	0,00	0,00	5 461,22	0,00	0,00	5 461,22
4	5 439,37	0,00	0,00	0,00	5 439,37	0,00	0,00	5 439,37
5	5 417,62	0,00	0,00	0,00	5 417,62	0,00	0,00	5 417,62
6	5 395,95	0,00	0,00	0,00	5 395,95	0,00	0,00	5 395,95
7	5 374,36	0,00	0,00	0,00	5 374,36	0,00	0,00	5 374,36
8	5 352,87	0,00	0,00	0,00	5 352,87	0,00	0,00	5 352,87
9	5 331,45	0,00	0,00	0,00	5 331,45	0,00	0,00	5 331,45
10	5 310,13	0,00	0,00	0,00	5 310,13	0,00	0,00	5 310,13
11	5 288,89	0,00	0,00	0,00	5 288,89	0,00	0,00	5 288,89
12	5 267,73	0,00	0,00	0,00	5 267,73	0,00	0,00	5 267,73
13	5 246,66	0,00	0,00	0,00	5 246,66	0,00	0,00	5 246,66
14	5 225,67	0,00	0,00	0,00	5 225,67	0,00	0,00	5 225,67
15	5 204,77	0,00	0,00	0,00	5 204,77	0,00	0,00	5 204,77
16	5 183,95	0,00	0,00	0,00	5 183,95	0,00	0,00	5 183,95
17	5 163,22	0,00	0,00	0,00	5 163,22	0,00	0,00	5 163,22
18	5 142,56	0,00	0,00	0,00	5 142,56	0,00	0,00	5 142,56
19	5 121,99	0,00	0,00	0,00	5 121,99	0,00	0,00	5 121,99
20	5 101,51	0,00	0,00	0,00	5 101,51	0,00	0,00	5 101,51
21	5 081,10	0,00	0,00	0,00	5 081,10	0,00	0,00	5 081,10
22	5 060,78	0,00	0,00	0,00	5 060,78	0,00	0,00	5 060,78
23	5 040,53	0,00	0,00	0,00	5 040,53	0,00	0,00	5 040,53
24	5 020,37	0,00	0,00	0,00	5 020,37	0,00	0,00	5 020,37
25	5 000,29	0,00	0,00	0,00	5 000,29	0,00	0,00	5 000,29
Tot	**131 221,31**	**0,00**	**0,00**	**0,00**	**131 221,31**	**0,00**	**0,00**	**131 221,31**
				Controllo	131 221,31			

Figure 24:energy production over 25 years

3. *Pian Di Rose primary school (40_Module)*

	Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso												
ora del giorno	gennaio	febbraio	marzo	aprile	maggio	giugno	luglio	agosto	settembre	ottobre	novembre	dicembre	Media
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,07	1,24	2,06	1,68	0,42	0,00	0,00	0,00	0,00	0,45
6,00	0,00	0,00	0,36	2,17	3,47	4,04	4,02	2,83	0,90	0,00	0,00	0,00	1,48
7,00	0,00	0,73	2,45	4,13	5,26	5,76	6,15	5,07	3,27	1,29	0,13	0,00	2,85
8,00	1,15	2,28	3,95	5,57	6,58	7,02	7,78	6,83	5,00	3,07	1,56	0,87	4,30
9,00	1,84	3,05	4,88	6,58	7,60	8,05	9,10	8,14	6,16	4,08	2,41	1,79	5,31
10,00	2,15	3,51	5,55	7,35	8,38	8,84	10,10	9,16	7,03	4,75	2,86	2,17	5,99
11,00	2,33	3,80	5,97	7,84	8,88	9,33	10,74	9,79	7,57	5,18	3,13	2,39	6,41
12,00	2,40	3,90	6,11	8,00	9,05	9,50	10,95	10,01	7,76	5,32	3,23	2,46	6,56
13,00	2,33	3,80	5,97	7,84	8,88	9,33	10,74	9,79	7,57	5,18	3,13	2,39	6,41
14,00	2,15	3,51	5,55	7,35	8,38	8,84	10,10	9,16	7,03	4,75	2,86	2,17	5,99
15,00	1,84	3,05	4,88	6,58	7,60	8,05	9,10	8,14	6,16	4,08	2,41	1,79	5,31
16,00	1,15	2,28	3,95	5,57	6,58	7,02	7,78	6,83	5,00	3,07	1,56	0,87	4,30
17,00	0,00	0,73	2,45	4,13	5,26	5,76	6,15	5,07	3,27	1,29	0,13	0,00	2,85
18,00	0,00	0,00	0,36	2,17	3,47	4,04	4,02	2,83	0,90	0,00	0,00	0,00	1,48
19,00	0,00	0,00	0,00	0,07	1,24	2,06	1,68	0,42	0,00	0,00	0,00	0,00	0,45
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	17,34	30,61	52,44	75,41	91,88	99,68	110,09	94,48	67,61	42,04	23,40	16,90	
controllo	17,34	30,61	52,44	75,41	91,88	99,68	110,09	94,48	67,61	42,04	23,40	16,90	Tot anno
Tot mese	537,42	857,06	1 625,70	2 262,38	2 848,34	2 990,50	3 412,64	2 928,96	2 028,34	1 303,25	702,12	523,99	22 020,69

Figure 25:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

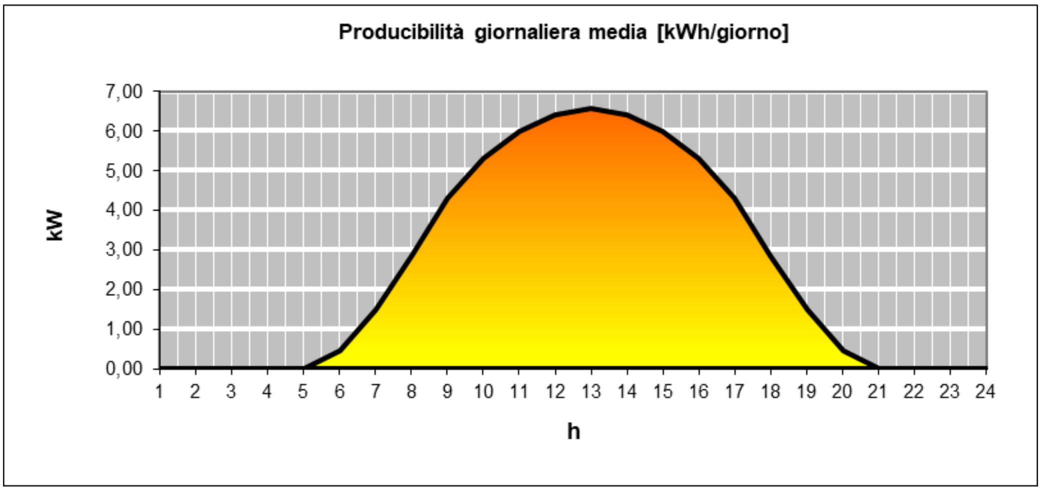


Figure 26:Daily Energy Production

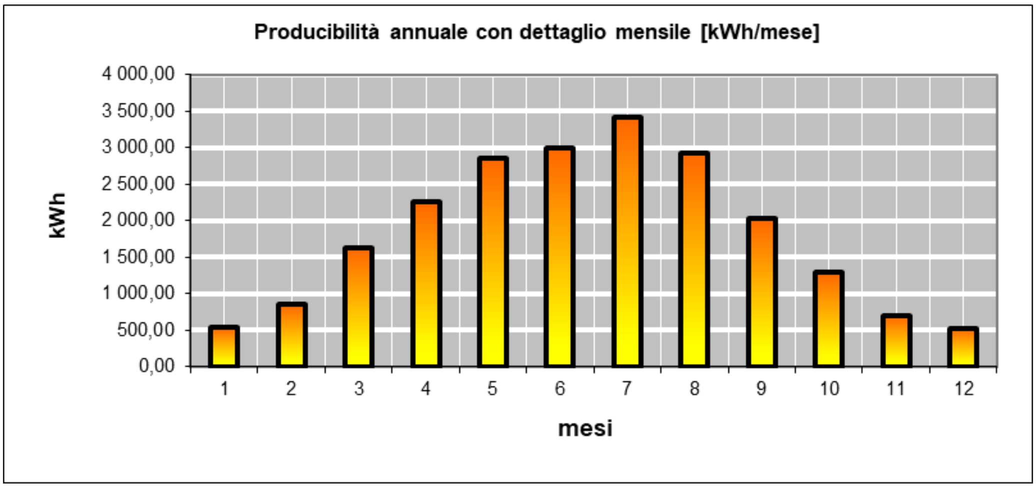


Figure 27:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	**Producibilità**	**Consumi**	**Consumi - giorno**	**Consumo - notte**	**Iniezione in rete**	**Copertura consumi**	**Prelievo dalla rete**	**Iniezione maggiorata**
1	22 020,69	0,00	0,00	0,00	22 020,69	0,00	0,00	22 020,69
2	21 932,61	0,00	0,00	0,00	21 932,61	0,00	0,00	21 932,61
3	21 844,88	0,00	0,00	0,00	21 844,88	0,00	0,00	21 844,88
4	21 757,50	0,00	0,00	0,00	21 757,50	0,00	0,00	21 757,50
5	21 670,47	0,00	0,00	0,00	21 670,47	0,00	0,00	21 670,47
6	21 583,79	0,00	0,00	0,00	21 583,79	0,00	0,00	21 583,79
7	21 497,45	0,00	0,00	0,00	21 497,45	0,00	0,00	21 497,45
8	21 411,46	0,00	0,00	0,00	21 411,46	0,00	0,00	21 411,46
9	21 325,81	0,00	0,00	0,00	21 325,81	0,00	0,00	21 325,81
10	21 240,51	0,00	0,00	0,00	21 240,51	0,00	0,00	21 240,51
11	21 155,55	0,00	0,00	0,00	21 155,55	0,00	0,00	21 155,55
12	21 070,93	0,00	0,00	0,00	21 070,93	0,00	0,00	21 070,93
13	20 986,64	0,00	0,00	0,00	20 986,64	0,00	0,00	20 986,64
14	20 902,70	0,00	0,00	0,00	20 902,70	0,00	0,00	20 902,70
15	20 819,09	0,00	0,00	0,00	20 819,09	0,00	0,00	20 819,09
16	20 735,81	0,00	0,00	0,00	20 735,81	0,00	0,00	20 735,81
17	20 652,87	0,00	0,00	0,00	20 652,87	0,00	0,00	20 652,87
18	20 570,25	0,00	0,00	0,00	20 570,25	0,00	0,00	20 570,25
19	20 487,97	0,00	0,00	0,00	20 487,97	0,00	0,00	20 487,97
20	20 406,02	0,00	0,00	0,00	20 406,02	0,00	0,00	20 406,02
21	20 324,40	0,00	0,00	0,00	20 324,40	0,00	0,00	20 324,40
22	20 243,10	0,00	0,00	0,00	20 243,10	0,00	0,00	20 243,10
23	20 162,13	0,00	0,00	0,00	20 162,13	0,00	0,00	20 162,13
24	20 081,48	0,00	0,00	0,00	20 081,48	0,00	0,00	20 081,48
25	20 001,15	0,00	0,00	0,00	20 001,15	0,00	0,00	20 001,15
Tot	**524 885,24**	**0,00**	**0,00**	**0,00**	**524 885,24**	**0,00**	**0,00**	**524 885,24**
				Controllo	524 885,24			

Figure 28:energy production over 25 years

VI.3.2. Carport

The upcoming section displays the results of the energy production analysis in detail. The first image features an Excel table that illustrates daily and monthly energy production for each hour of the year, measured in kilowatt-hours (kWh). Brighter colours indicate increased energy output during midday, particularly in the summer. Additionally, the charts offer a visual representation of both daily and monthly production trends, while the final image presents an overall summary of the photovoltaic system's projected energy output over 25 years.

Pian Di Rose Primary School Parking

Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso													
ora del giorno	gennaio	febbraio	marzo	aprile	maggio	giugno	luglio	agosto	settembre	ottobre	novembre	dicembre	Media
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,33	5,85	9,57	8,25	2,14	0,00	0,00	0,00	0,00	2,18
6,00	0,00	0,00	1,73	10,03	15,60	17,94	18,40	13,38	4,37	0,00	0,00	0,00	6,79
7,00	0,00	3,27	11,04	18,11	22,75	24,74	26,88	22,52	14,83	5,97	0,61	0,00	12,56
8,00	4,96	9,84	16,91	23,58	27,60	29,39	32,87	29,08	21,51	13,40	6,85	3,82	18,32
9,00	7,64	12,64	20,19	27,08	31,15	32,95	37,44	33,66	25,56	17,04	10,10	7,54	21,92
10,00	8,64	14,13	22,35	29,58	33,69	35,50	40,70	36,93	28,37	19,21	11,55	8,76	24,12
11,00	9,15	14,91	23,50	30,89	35,03	36,84	42,42	38,65	29,85	20,36	12,30	9,36	25,27
12,00	9,17	14,95	23,54	30,95	35,08	36,89	42,49	38,72	29,91	20,40	12,33	9,38	25,32
13,00	8,70	14,22	22,49	29,73	33,85	35,66	40,90	37,13	28,54	19,35	11,63	8,83	24,25
14,00	7,78	12,79	20,40	27,33	31,41	33,21	37,77	33,99	25,84	17,25	10,27	7,75	22,15
15,00	6,43	10,74	17,43	23,91	27,93	29,72	33,30	29,50	21,99	14,27	8,29	6,12	19,14
16,00	3,92	7,69	13,59	19,70	23,64	25,42	27,80	23,99	17,16	10,17	5,08	2,89	15,09
17,00	0,00	2,45	7,99	14,06	18,44	20,38	21,31	17,10	10,57	4,10	0,49	0,00	9,74
18,00	0,00	0,00	1,30	7,12	11,76	13,89	13,32	8,88	2,86	0,00	0,00	0,00	4,93
19,00	0,00	0,00	0,00	0,26	4,18	6,90	5,35	1,41	0,00	0,00	0,00	0,00	1,51
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	66,40	117,63	202,47	292,68	357,94	388,99	429,19	367,09	261,36	161,52	89,48	64,46	
controllo	66,40	117,63	202,47	292,68	357,94	388,99	429,19	367,09	261,36	161,52	89,48	64,46	Tot anno
Tot mese	2 058,28	3 293,69	6 276,50	8 780,31	11 096,28	11 669,59	13 304,95	11 379,76	7 840,74	5 007,16	2 684,47	1 998,28	85 390,00

Figure 29:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

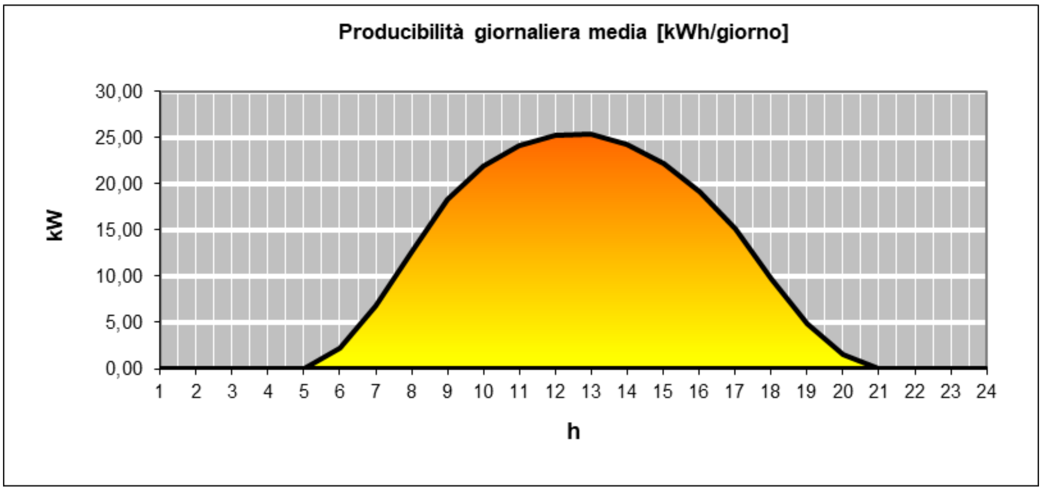


Figure 30:Daily Energy Production

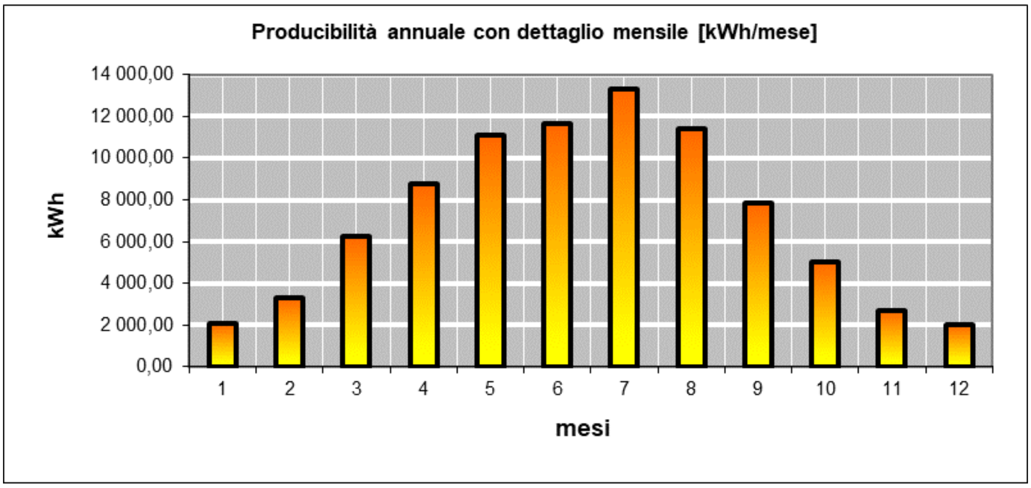


Figure 31:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	**Producibilità**	**Consumi**	**Consumi - giorno**	**Consumo - notte**	**Iniezione in rete**	**Copertura consumi**	**Prelievo dalla rete**	**Iniezione maggiorata**
1	85 390,00	0,00	0,00	0,00	85 390,00	0,00	0,00	87 353,97
2	85 048,44	0,00	0,00	0,00	85 048,44	0,00	0,00	87 004,55
3	84 708,25	0,00	0,00	0,00	84 708,25	0,00	0,00	86 656,54
4	84 369,41	0,00	0,00	0,00	84 369,41	0,00	0,00	86 309,91
5	84 031,94	0,00	0,00	0,00	84 031,94	0,00	0,00	85 964,67
6	83 695,81	0,00	0,00	0,00	83 695,81	0,00	0,00	85 620,81
7	83 361,02	0,00	0,00	0,00	83 361,02	0,00	0,00	85 278,33
8	83 027,58	0,00	0,00	0,00	83 027,58	0,00	0,00	84 937,21
9	82 695,47	0,00	0,00	0,00	82 695,47	0,00	0,00	84 597,47
10	82 364,69	0,00	0,00	0,00	82 364,69	0,00	0,00	84 259,08
11	82 035,23	0,00	0,00	0,00	82 035,23	0,00	0,00	83 922,04
12	81 707,09	0,00	0,00	0,00	81 707,09	0,00	0,00	83 586,35
13	81 380,26	0,00	0,00	0,00	81 380,26	0,00	0,00	83 252,01
14	81 054,74	0,00	0,00	0,00	81 054,74	0,00	0,00	82 919,00
15	80 730,52	0,00	0,00	0,00	80 730,52	0,00	0,00	82 587,32
16	80 407,60	0,00	0,00	0,00	80 407,60	0,00	0,00	82 256,97
17	80 085,97	0,00	0,00	0,00	80 085,97	0,00	0,00	81 927,95
18	79 765,62	0,00	0,00	0,00	79 765,62	0,00	0,00	81 600,23
19	79 446,56	0,00	0,00	0,00	79 446,56	0,00	0,00	81 273,83
20	79 128,78	0,00	0,00	0,00	79 128,78	0,00	0,00	80 948,74
21	78 812,26	0,00	0,00	0,00	78 812,26	0,00	0,00	80 624,94
22	78 497,01	0,00	0,00	0,00	78 497,01	0,00	0,00	80 302,44
23	78 183,02	0,00	0,00	0,00	78 183,02	0,00	0,00	79 981,23
24	77 870,29	0,00	0,00	0,00	77 870,29	0,00	0,00	79 661,31
25	77 558,81	0,00	0,00	0,00	77 558,81	0,00	0,00	79 342,66
Tot	**2 035 356,37**	**0,00**	**0,00**	**0,00**	**2 035 356,37**	**0,00**	**0,00**	**2 082 169,56**
				Controllo	2 035 356,37			

Figure 32:energy production over 25 years

Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso													
ora del giorno	**gennaio**	**febbraio**	**marzo**	**aprile**	**maggio**	**giugno**	**luglio**	**agosto**	**settembre**	**ottobre**	**novembre**	**dicembre**	**Media**
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,44	8,15	13,62	11,29	2,75	0,00	0,00	0,00	0,00	3,02
6,00	0,00	0,00	2,17	13,45	21,94	25,65	25,62	17,77	5,41	0,00	0,00	0,00	9,33
7,00	0,00	4,12	14,37	24,95	32,43	35,72	38,08	30,90	19,33	7,22	0,77	0,00	17,33
8,00	6,36	12,86	22,91	33,25	39,92	42,94	47,36	40,92	29,19	17,26	8,43	4,68	25,51
9,00	10,17	17,17	28,17	38,97	45,74	48,78	54,84	48,41	35,77	22,95	13,17	9,65	31,15
10,00	11,91	19,78	31,99	43,37	50,22	53,28	60,61	54,18	40,71	26,77	15,69	11,75	35,02
11,00	12,97	21,44	34,41	46,17	53,07	56,15	64,27	57,85	43,86	29,19	17,27	13,00	37,47
12,00	13,35	22,04	35,27	47,17	54,09	57,17	65,58	59,16	44,98	30,06	17,84	13,45	38,34
13,00	13,02	21,52	34,52	46,30	53,21	56,28	64,44	58,02	44,00	29,30	17,35	13,06	37,59
14,00	12,00	19,93	32,21	43,62	50,48	53,54	60,94	54,51	41,00	26,99	15,84	11,86	35,24
15,00	10,31	17,38	28,48	39,33	46,10	49,15	55,31	48,87	36,17	23,26	13,37	9,81	31,46
16,00	6,47	13,10	23,29	33,69	40,36	43,39	47,94	41,49	29,68	17,62	8,64	4,77	25,87
17,00	0,00	4,20	14,72	25,41	32,92	36,22	38,71	31,51	19,81	7,45	0,77	0,00	17,64
18,00	0,00	0,00	2,23	13,80	22,38	26,11	26,19	18,28	5,61	0,00	0,00	0,00	9,55
19,00	0,00	0,00	0,00	0,45	8,35	13,93	11,63	2,86	0,00	0,00	0,00	0,00	3,10
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	96,56	173,56	304,74	450,36	559,35	611,94	672,83	567,47	395,52	238,06	129,13	92,01	
controllo	96,56	173,56	304,74	450,36	559,35	611,94	672,83	567,47	395,52	238,06	129,13	92,01	**Tot anno**
Tot mese	2 993,27	4 859,77	9 447,03	13 510,79	17 339,93	18 358,11	20 857,58	17 591,46	11 865,63	7 380,01	3 874,00	2 852,39	130 930,00

Figure 33:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

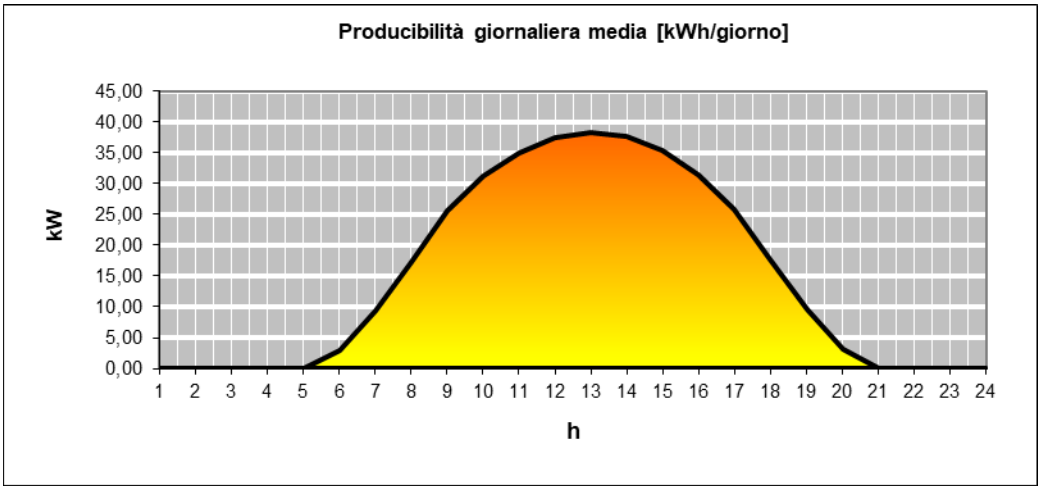


Figure 34:Daily Energy Production

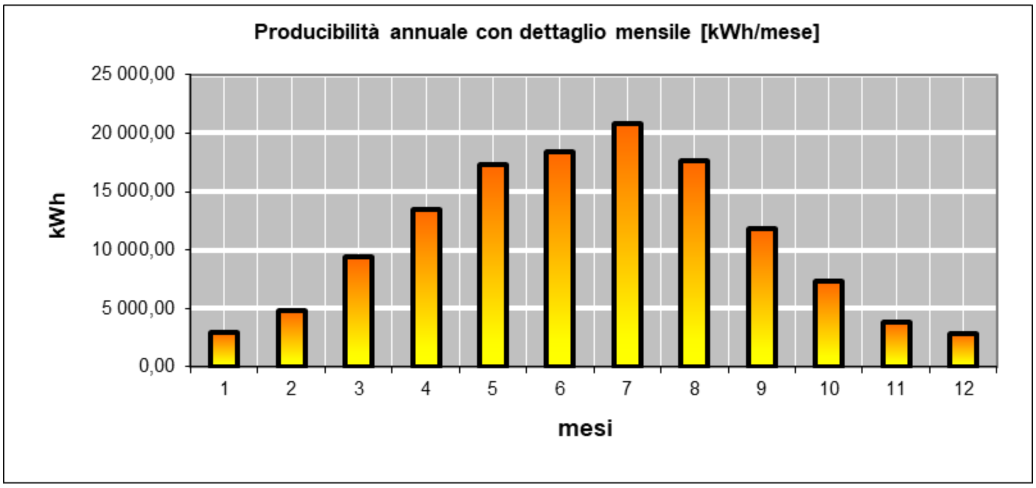


Figure 35:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	**Producibilità**	**Consumi**	**Consumi - giorno**	**Consumo - notte**	**Iniezione in rete**	**Copertura consumi**	**Prelievo dalla rete**	**Iniezione maggiorata**
1	130 930,00	0,00	0,00	0,00	130 930,00	0,00	0,00	130 930,00
2	130 406,28	0,00	0,00	0,00	130 406,28	0,00	0,00	130 406,28
3	129 884,65	0,00	0,00	0,00	129 884,65	0,00	0,00	129 884,65
4	129 365,12	0,00	0,00	0,00	129 365,12	0,00	0,00	129 365,12
5	128 847,66	0,00	0,00	0,00	128 847,66	0,00	0,00	128 847,66
6	128 332,27	0,00	0,00	0,00	128 332,27	0,00	0,00	128 332,27
7	127 818,94	0,00	0,00	0,00	127 818,94	0,00	0,00	127 818,94
8	127 307,66	0,00	0,00	0,00	127 307,66	0,00	0,00	127 307,66
9	126 798,43	0,00	0,00	0,00	126 798,43	0,00	0,00	126 798,43
10	126 291,24	0,00	0,00	0,00	126 291,24	0,00	0,00	126 291,24
11	125 786,07	0,00	0,00	0,00	125 786,07	0,00	0,00	125 786,07
12	125 282,93	0,00	0,00	0,00	125 282,93	0,00	0,00	125 282,93
13	124 781,80	0,00	0,00	0,00	124 781,80	0,00	0,00	124 781,80
14	124 282,67	0,00	0,00	0,00	124 282,67	0,00	0,00	124 282,67
15	123 785,54	0,00	0,00	0,00	123 785,54	0,00	0,00	123 785,54
16	123 290,40	0,00	0,00	0,00	123 290,40	0,00	0,00	123 290,40
17	122 797,23	0,00	0,00	0,00	122 797,23	0,00	0,00	122 797,23
18	122 306,04	0,00	0,00	0,00	122 306,04	0,00	0,00	122 306,04
19	121 816,82	0,00	0,00	0,00	121 816,82	0,00	0,00	121 816,82
20	121 329,55	0,00	0,00	0,00	121 329,55	0,00	0,00	121 329,55
21	120 844,23	0,00	0,00	0,00	120 844,23	0,00	0,00	120 844,23
22	120 360,86	0,00	0,00	0,00	120 360,86	0,00	0,00	120 360,86
23	119 879,41	0,00	0,00	0,00	119 879,41	0,00	0,00	119 879,41
24	119 399,90	0,00	0,00	0,00	119 399,90	0,00	0,00	119 399,90
25	118 922,30	0,00	0,00	0,00	118 922,30	0,00	0,00	118 922,30
Tot	**3 120 847,98**	**0,00**	**0,00**	**0,00**	**3 120 847,98**	**0,00**	**0,00**	**3 120 847,98**
				Controllo	3 120 847,98			

Figure 36:energy production over 25 years

Pian di rose school walkway

	Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso												
ora del giorno	gennaio	febbraio	marzo	aprile	maggio	giugno	luglio	agosto	settembre	ottobre	novembre	dicembre	Media
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,26	4,51	7,60	6,06	1,45	0,00	0,00	0,00	0,00	1,66
6,00	0,00	0,00	1,27	7,52	12,51	14,72	14,42	9,77	2,97	0,00	0,00	0,00	5,27
7,00	0,00	2,42	8,19	14,44	18,95	20,94	22,09	17,74	10,94	4,10	0,48	0,00	10,02
8,00	3,80	7,54	13,49	19,70	23,75	25,58	28,06	24,13	17,13	10,04	4,93	2,79	15,08
9,00	6,12	10,33	16,95	23,49	27,60	29,45	33,01	29,09	21,48	13,75	7,88	5,77	18,75
10,00	7,31	12,13	19,57	26,51	30,68	32,54	36,96	33,05	24,87	16,38	9,62	7,20	21,40
11,00	8,09	13,34	21,34	28,55	32,76	34,63	39,64	35,73	27,17	18,15	10,78	8,12	23,19
12,00	8,45	13,90	22,15	29,48	33,71	35,58	40,85	36,95	28,21	18,96	11,31	8,54	24,01
13,00	8,35	13,75	21,93	29,23	33,46	35,33	40,53	36,63	27,94	18,75	11,17	8,43	23,79
14,00	7,82	12,91	20,72	27,83	32,02	33,89	38,69	34,78	26,36	17,53	10,37	7,80	22,56
15,00	6,83	11,44	18,57	25,36	29,51	31,37	35,46	31,55	23,58	15,38	8,94	6,60	20,38
16,00	4,37	8,81	15,44	21,99	26,08	27,93	31,06	27,13	19,69	11,94	5,95	3,28	16,97
17,00	0,00	2,89	9,98	16,83	21,49	23,52	25,38	20,95	13,46	5,22	0,52	0,00	11,69
18,00	0,00	0,00	1,55	9,31	14,78	17,12	17,42	12,43	3,93	0,00	0,00	0,00	6,38
19,00	0,00	0,00	0,00	0,31	5,58	9,22	7,88	1,99	0,00	0,00	0,00	0,00	2,08
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	61,14	109,47	191,16	280,80	347,38	379,42	417,51	353,38	247,71	150,20	81,94	58,55	
controllo	61,14	109,47	191,16	280,80	347,38	379,42	417,51	353,38	247,71	150,20	81,94	58,55	Tot anno
Tot mese	1 895,25	3 065,29	5 925,84	8 424,03	10 768,86	11 382,55	12 942,96	10 954,66	7 431,23	4 656,08	2 458,20	1 815,06	81 720,00

Figure 37:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

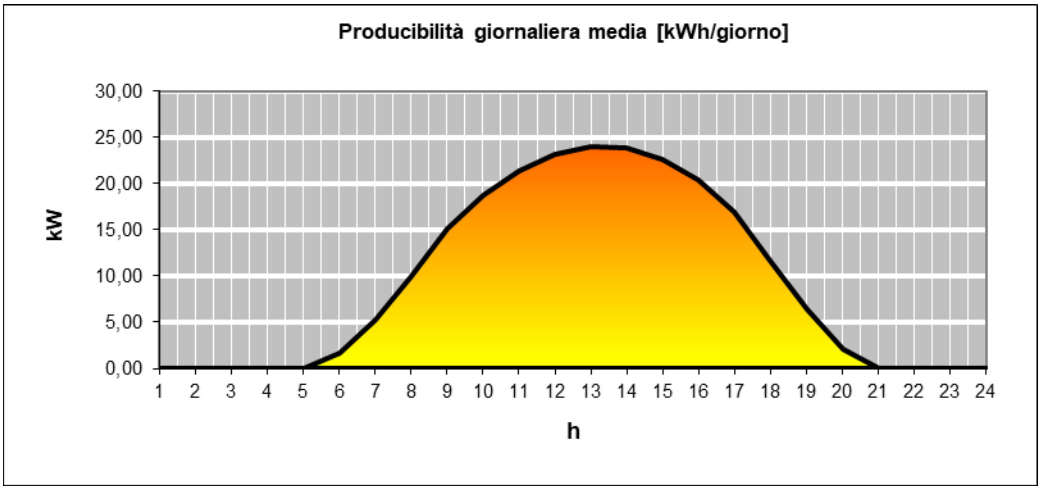


Figure 38:Daily Energy Production

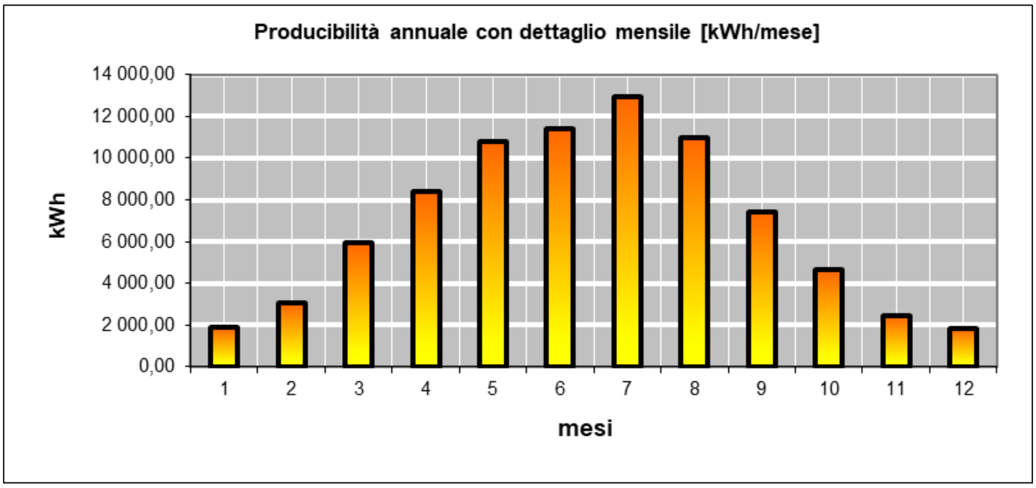


Figure 39:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	**Producibilità**	**Consumi**	**Consumi - giorno**	**Consumo - notte**	**Iniezione in rete**	**Copertura consumi**	**Prelievo dalla rete**	**Iniezione maggiorata**
1	81 720,00	0,00	0,00	0,00	81 720,00	0,00	0,00	81 720,00
2	81 393,12	0,00	0,00	0,00	81 393,12	0,00	0,00	81 393,12
3	81 067,55	0,00	0,00	0,00	81 067,55	0,00	0,00	81 067,55
4	80 743,28	0,00	0,00	0,00	80 743,28	0,00	0,00	80 743,28
5	80 420,30	0,00	0,00	0,00	80 420,30	0,00	0,00	80 420,30
6	80 098,62	0,00	0,00	0,00	80 098,62	0,00	0,00	80 098,62
7	79 778,23	0,00	0,00	0,00	79 778,23	0,00	0,00	79 778,23
8	79 459,12	0,00	0,00	0,00	79 459,12	0,00	0,00	79 459,12
9	79 141,28	0,00	0,00	0,00	79 141,28	0,00	0,00	79 141,28
10	78 824,71	0,00	0,00	0,00	78 824,71	0,00	0,00	78 824,71
11	78 509,42	0,00	0,00	0,00	78 509,42	0,00	0,00	78 509,42
12	78 195,38	0,00	0,00	0,00	78 195,38	0,00	0,00	78 195,38
13	77 882,60	0,00	0,00	0,00	77 882,60	0,00	0,00	77 882,60
14	77 571,07	0,00	0,00	0,00	77 571,07	0,00	0,00	77 571,07
15	77 260,78	0,00	0,00	0,00	77 260,78	0,00	0,00	77 260,78
16	76 951,74	0,00	0,00	0,00	76 951,74	0,00	0,00	76 951,74
17	76 643,93	0,00	0,00	0,00	76 643,93	0,00	0,00	76 643,93
18	76 337,36	0,00	0,00	0,00	76 337,36	0,00	0,00	76 337,36
19	76 032,01	0,00	0,00	0,00	76 032,01	0,00	0,00	76 032,01
20	75 727,88	0,00	0,00	0,00	75 727,88	0,00	0,00	75 727,88
21	75 424,97	0,00	0,00	0,00	75 424,97	0,00	0,00	75 424,97
22	75 123,27	0,00	0,00	0,00	75 123,27	0,00	0,00	75 123,27
23	74 822,77	0,00	0,00	0,00	74 822,77	0,00	0,00	74 822,77
24	74 523,48	0,00	0,00	0,00	74 523,48	0,00	0,00	74 523,48
25	74 225,39	0,00	0,00	0,00	74 225,39	0,00	0,00	74 225,39
Tot	**1 947 878,23**	**0,00**	**0,00**	**0,00**	**1 947 878,23**	**0,00**	**0,00**	**1 947 878,23**
				Controllo	1 947 878,23			

Figure 40:energy production over 25 years

Distribuzione statistica kWh giornalieri prodotti in un giorno tipico di uno specifico mese dell'anno - Sistema fisso													
ora del giorno	**gennaio**	**febbraio**	**marzo**	**aprile**	**maggio**	**giugno**	**luglio**	**agosto**	**settembre**	**ottobre**	**novembre**	**dicembre**	**Media**
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5,00	0,00	0,00	0,00	0,37	6,47	10,60	9,13	2,37	0,00	0,00	0,00	0,00	2,41
6,00	0,00	0,00	1,90	11,05	17,22	19,81	20,31	14,75	4,80	0,00	0,00	0,00	7,49
7,00	0,00	3,58	12,11	19,93	25,07	27,29	29,63	24,79	16,29	6,53	0,67	0,00	13,82
8,00	5,42	10,77	18,56	25,94	30,40	32,39	36,21	31,99	23,61	14,67	7,48	4,17	20,13
9,00	8,35	13,84	22,15	29,78	34,30	36,31	41,23	37,02	28,06	18,65	11,03	8,22	24,08
10,00	9,46	15,48	24,53	32,52	37,09	39,10	44,81	40,61	31,14	21,04	12,62	9,57	26,50
11,00	10,02	16,35	25,79	33,98	38,57	40,59	46,71	42,52	32,78	22,31	13,45	10,23	27,77
12,00	10,04	16,39	25,85	34,04	38,64	40,66	46,80	42,61	32,86	22,37	13,49	10,26	27,83
13,00	9,54	15,60	24,71	32,72	37,29	39,31	45,08	40,88	31,37	21,22	12,74	9,66	26,68
14,00	8,53	14,04	22,43	30,10	34,63	36,63	41,65	37,44	28,42	18,94	11,24	8,48	24,38
15,00	7,05	11,80	19,18	26,36	30,82	32,82	36,76	32,54	24,21	15,68	9,09	6,70	21,08
16,00	4,30	8,45	14,98	21,75	26,14	28,12	30,74	26,50	18,93	11,19	5,57	3,17	16,65
17,00	0,00	2,71	8,83	15,57	20,43	22,58	23,63	18,94	11,69	4,52	0,54	0,00	10,79
18,00	0,00	0,00	1,44	7,89	13,08	15,44	14,84	9,90	3,17	0,00	0,00	0,00	5,48
19,00	0,00	0,00	0,00	0,29	4,65	7,70	5,99	1,55	0,00	0,00	0,00	0,00	1,68
20,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
22,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
23,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
kWh/giorno	72,71	129,00	222,47	322,30	394,80	429,34	473,54	404,43	287,33	177,12	97,92	70,46	
controllo	72,71	129,00	222,47	322,30	394,80	429,34	473,54	404,43	287,33	177,12	97,92	70,46	**Tot anno**
Tot mese	2 254,02	3 612,08	6 896,63	9 669,03	12 238,77	12 880,11	14 679,60	12 537,32	8 619,91	5 490,58	2 937,60	2 184,34	94 000,00

Figure 41:detailed table displaying the daily and monthly energy production of a fixed photovoltaic system

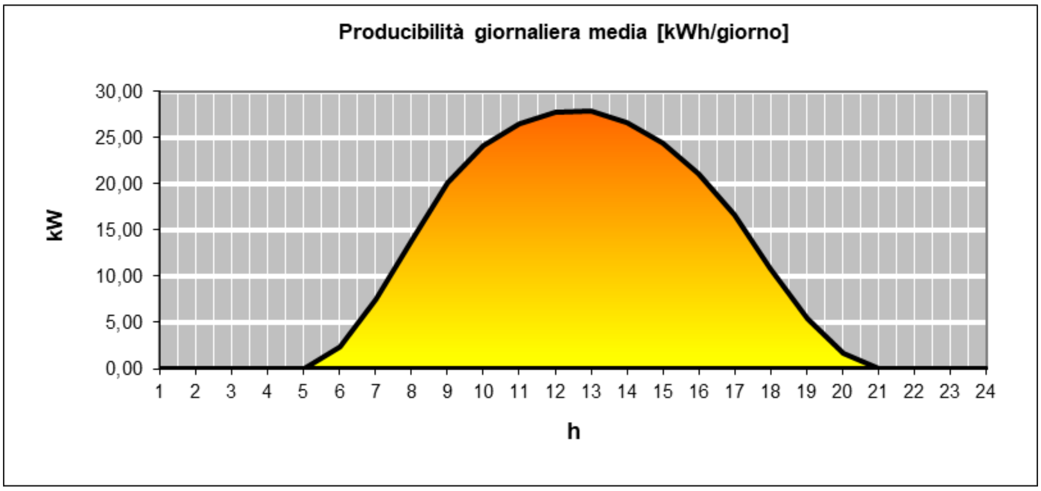


Figure 42:Daily Energy Production

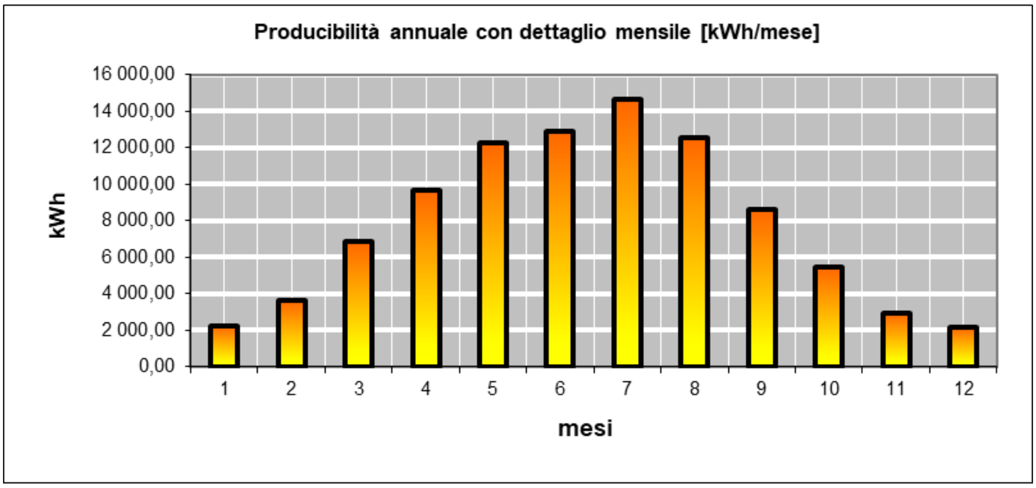


Figure 43:Monthly Energy Production

Orizzonte temporale a 25 anni

Perdita di efficienza annuale Impianto FV	0,40%
Tasso variazione annuale consumi	0,00%
Sistema di accumulo	NO

Consumi al primo anno	0,00%	della producibilità
Consumi 25 anni	0,00%	della producibilità 25 anni
Autoconsumo	0,00%	della producibilità
Autoconsumo 25 anni	0,00%	della producibilità 25 anni
Riduzione consumi	0,00%	rispetto ai consumi primo anno
Riduzione consumi	0,00%	rispetto ai consumi 25 anni

	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
Anno	**Producibilità**	**Consumi**	**Consumi - giorno**	**Consumo - notte**	**Iniezione in rete**	**Copertura consumi**	**Prelievo dalla rete**	**Iniezione maggiorata**
1	94 000,00	0,00	0,00	0,00	94 000,00	0,00	0,00	94 000,00
2	93 624,00	0,00	0,00	0,00	93 624,00	0,00	0,00	93 624,00
3	93 249,50	0,00	0,00	0,00	93 249,50	0,00	0,00	93 249,50
4	92 876,51	0,00	0,00	0,00	92 876,51	0,00	0,00	92 876,51
5	92 505,00	0,00	0,00	0,00	92 505,00	0,00	0,00	92 505,00
6	92 134,98	0,00	0,00	0,00	92 134,98	0,00	0,00	92 134,98
7	91 766,44	0,00	0,00	0,00	91 766,44	0,00	0,00	91 766,44
8	91 399,37	0,00	0,00	0,00	91 399,37	0,00	0,00	91 399,37
9	91 033,78	0,00	0,00	0,00	91 033,78	0,00	0,00	91 033,78
10	90 669,64	0,00	0,00	0,00	90 669,64	0,00	0,00	90 669,64
11	90 306,96	0,00	0,00	0,00	90 306,96	0,00	0,00	90 306,96
12	89 945,74	0,00	0,00	0,00	89 945,74	0,00	0,00	89 945,74
13	89 585,95	0,00	0,00	0,00	89 585,95	0,00	0,00	89 585,95
14	89 227,61	0,00	0,00	0,00	89 227,61	0,00	0,00	89 227,61
15	88 870,70	0,00	0,00	0,00	88 870,70	0,00	0,00	88 870,70
16	88 515,22	0,00	0,00	0,00	88 515,22	0,00	0,00	88 515,22
17	88 161,15	0,00	0,00	0,00	88 161,15	0,00	0,00	88 161,15
18	87 808,51	0,00	0,00	0,00	87 808,51	0,00	0,00	87 808,51
19	87 457,28	0,00	0,00	0,00	87 457,28	0,00	0,00	87 457,28
20	87 107,45	0,00	0,00	0,00	87 107,45	0,00	0,00	87 107,45
21	86 759,02	0,00	0,00	0,00	86 759,02	0,00	0,00	86 759,02
22	86 411,98	0,00	0,00	0,00	86 411,98	0,00	0,00	86 411,98
23	86 066,33	0,00	0,00	0,00	86 066,33	0,00	0,00	86 066,33
24	85 722,07	0,00	0,00	0,00	85 722,07	0,00	0,00	85 722,07
25	85 379,18	0,00	0,00	0,00	85 379,18	0,00	0,00	85 379,18
Tot	**2 240 584,36**	**0,00**	**0,00**	**0,00**	**2 240 584,36**	**0,00**	**0,00**	**2 240 584,36**
				Controllo	2 240 584,36			

Figure 44:energy production over 25 years

ID	code	site	system power kWp	annual energy produced kWp	January kWh	February kWh	March kWh	Aprile kWh	May kWh	June kWh	July kWh	August kWh	September kWh	October kWh	November kWh	December kWh	
										Monthly production							
1	-	Sant' Ippolito Cemetery	19,32	25 010,0	846,0	1 224,0	2 074,0	2 600,0	3 190,0	3 225,0	3 503,0	2 973,0	2 238,0	1 499,0	913,0	721,0	25010,0
2	-	Pian Di Rose Primary School Parking	79,65	85 390,0	2 531,0	4 099,0	6 858,0	9 112,0	11 302,0	11 380,0	12 126	10 377	7 534,0	4 800,0	2 997,0	2 273,0	85390,0
3	-	Pian Di Rose Primary School	26,10	31 930,0	1 002,0	1 526,0	2 624,0	3 331,0	4 139,0	4 203,0	4 554,0	3 831,0	2 831,0	1 864,0	1 128,0	873,0	31930,0
4	-	Sant Ippolito Evolution Camp	83,70	94 000,0	2 856,0	4 373,0	7 614,0	9 911,0	12 454,0	12 570,0	13 403,0	11 395,0	8 360,0	5 351,0	3 192,0	2 524,0	94000,0
5	-	shopping centre San. Vincenzo Parking	126,90	130 930,0	3 550,0	4 609,0	7 933,0	13 246,0	19 980,0	19 675,0	22 005,0	17 252,0	9 503,0	6 445,0	3 993,0	3 188,0	130 930,0
6	-	Pian di rose school walkway	73,35	81 720,0	2 020,0	3 355,0	6 343,0	8 766,0	11 320,0	11 730,0	12 649,0	10 105,0	7 025,0	4 150,0	2 434,0	1 825,0	81720,0
		Total PV production	409,02	448 980,0	12 805,0	19 186,0	33 446,0	46 966,0	62 385,0	62 783,0	68 240,0	55 933,0	37 491,0	24 109,0	14 657,0	11 404,0	

Table 14:Summary of the monthly photovoltaic production for each PV plant

VII. Economical Description

VII.1. Project financing

Energy communities require reliable funding to initiate their projects. Various financing models are available, each offering distinct advantages and constraints.

One of the most critical factors to consider when securing financing is understanding how the chosen model will impact the ownership structure of the energy project.

The relationship between financing and ownership is crucial. The negotiation process of any project financing should be around where your resources are coming from, and how much control you need to provide in order to access those resources. Of course, in the process of building the financing plan of your energy community, you should keep in mind two key principles: the principle of autonomy which guides any energy community to remain independent from external entities, and the principle of democratic control, which provides for a transparent governance of your organisation. [38]

To establish an effective financing plan, the following key questions must be addressed:

- **How much funding is required?** This question pertains not only to the total amount of financing needed but also to the timing for when the funds should be mobilized.
- **What type of financing is most appropriate?** This involves choosing the funding mechanism that aligns with the community's sustainability and long-term objectives.
- **What ownership model best aligns with the project's goals?** This is a fundamental consideration. The purpose of an energy community is to remain autonomous and democratic, reinforcing its transformative role. Therefore, the ownership structure must be a central part of the financing discussions.

VII.1.1. Advantages and critical issues of the tool

Firstly, it should be noted that while this tool has been widely used in the past, the absence of specific regulatory frameworks has often led to negative experiences. These issues have prompted a new approach to Public-Private Partnerships (PPPs), both from public entities and economic operators.

Legislative Decree No. 50/2016 introduced regulations governing this area, enabling the market to offer innovative solutions [39]. This tool should be considered and applied when it meets specific requirements and offers balanced benefits for both the public administration and economic operators. The advantages can be seen in the following aspects:

- The public administration (PA) can leverage private sector resources and expertise.
- Project completion timelines can be accelerated.
- A more effective risk management strategy can be developed for project-related risks.
- Under certain conditions, the contracting authority's budget can be alleviated.

Regarding the critical issues, the following points should be considered:

- A business culture more focused on sales than management.
- Uncertainty due to political changes and delays in investment implementation.
- Challenges in properly assigning entrepreneurial risk.
- The contracting authority's technical capacity to manage relationships with private entities.

VII.1.2. The Concept of Risk

Article 3 eee) of Legislative Decree No. 50/2016 [40]defines a "*public-private partnership (PPP) contract*" as a paid contract, documented in writing, where one or more contracting authorities assign to one or more economic operators, for a fixed period corresponding to the amortization of the investment or the established financing methods, a set of activities including the creation, transformation, maintenance, and operational management of a work. In exchange for these activities, the operator is granted availability, economic exploitation, or the provision of a service related to the work, with the assumption of risk as outlined in the contract.

Subject to the communication obligations set forth in **Article 44, paragraph 1-bis** of **Decree-Law No. 248 of December 31, 2007** [41], converted into law with amendments by **Law No. 31 of February 28, 2008**, Eurostat decisions apply only in terms of public finance protection.

This definition, further detailed in **Anac Guideline No. 9** [42], establishes the following principles:

a) **Risk Allocation**: The risk should be assigned to the party best able to manage it.

b) **Cost Efficiency**: It is necessary to verify which party can mitigate each risk at the lowest cost.

c) **Clarity in Contracts**: The contract must clearly and precisely define which parties assume each risk.

d) **Service Level Agreement (SLA) and Key Performance Indicators (KPIs)**: Quality performance indicators must be defined to measure service delivery.

Understanding the concept of risk, along with the various types of risk, is crucial. Some common types include:

- **Operational Risk**: Relates to the management of works or services, whether on the demand or supply side. The concessionaire assumes operational risk if, under normal conditions, the recovery of investments or costs incurred is not guaranteed.
- **Construction Risk**: Involves the risk of delays in project delivery, failure to meet design standards, cost overruns, technical issues, or project non-completion.
- **Availability Risk**: Pertains to the concessionaire's ability to deliver the contracted services in terms of both volume and quality standards.
- **Demand Risk**: Concerns fluctuations in demand for the service, including the possibility of insufficient users, which can lead to cash flow shortages.

Regarding **Availability and Demand risk**, the payment mechanism is typically linked to the economic operator's performance. There are various sources of revenue within a PPP contract, primarily stemming either from management operations or tariffs imposed on the public administration:

a) **Revenue from User Tariffs**: This model sees the revenue from management 'derived from fees paid by users of the work or service' as the primary source of remuneration for the concessionaire. Examples include highways, parking lots, and local public transport, representing **demand risk**.

b) **Revenue from Public Administration Tariffs**: In this case, the administration pays an availability fee to cover the cost of the investment and maintenance aimed at ensuring the availability of the infrastructure. Examples include public lighting services and energy efficiency improvements in buildings, representing **availability risk**.

Legislative Decree No. 50 of 2016 provides a structured framework for PPPs with the aim of encouraging the use of innovative tools for executing complex public works. This framework involves private entrepreneurship not only in the construction and management phases but also in securing financing and assuming the economic exploitation risks associated with the infrastructure. The allocation of "risk" is, therefore, a key aspect of PPPs, both at the project's inception and throughout its lifespan.

Proper risk allocation is essential for ensuring effective contract management and the successful fulfilment of public needs and objectives, which underpin the decision to use PPPs in the first place.

VII.1.3. The Concept of Economic and Financial Balance

Article 3 fff) of Legislative Decree No. 50/2016 [40] defines "*economic and financial balance*" as the simultaneous existence of conditions ensuring both economic viability and financial sustainability. Economic viability refers to the project's capacity to create value over the contract duration and to generate an adequate return on invested capital. Financial sustainability concerns the project's ability to generate sufficient cash flows to guarantee the repayment of financing.

The economic-financial plan is a key component of any project financing proposal, serving as a tool for assessing both economic and financial viability. From an economic standpoint, the plan compares expected costs and revenues, while from a financial perspective, it examines the inflows and outflows necessary to sustain the project. The goal of this analysis is to determine the project's feasibility, first by evaluating its ability to generate income independently of the financial structure, and then by assessing whether the project can generate cash flows sufficient to repay financing and ensure satisfactory returns on equity.

Key input data include estimates of demand, project timelines, implementation methods, revenue composition (such as the annual fee), and the breakdown of costs, all of which are aligned with the service management timeline and methods. The economic and financial indices derived from these inputs must accurately reflect the project's economic and financial balance.

The process also includes the formulation of alternative simulations, considering the use of any available financial resources from the entity, with the aim of optimizing project duration or facilitating additional investments. This approach provides maximum strategic flexibility for the municipality, enabling it to adjust the project scope or timing to align with broader financial and strategic goals.

VII.1.4. Focus on Private Initiative Project Finance

The Public Procurement Code permits economic operators to submit project proposals to contracting authorities for concession-based construction of public or public utility works, including structures dedicated to recreational boating, which are not included in the programming tools approved by the contracting authority under current legislation.

This means that **Legislative Decree No. 50/2016** identifies private initiative project finance proposals as only those works not present in approved programming tools. However, the Simplifications Decree introduces a significant amendment. **Article 8, paragraph 5, letter d)** ("*Other urgent provisions regarding public contracts*"), now allows proposals under **Article 183, paragraph 15** of the Code to be submitted **"***even if they are already present in the programming tools approved by the contracting authority based on current legislation.***"**

As a result, project proposals may now include works and services that are already part of public programming tools, especially where they may be deemed insufficient or where the related works or services have not yet been tendered by the administrations.

Proposal Documents

The proposal must include:

- A feasibility study
- A draft agreement
- An economic-financial plan certified by one of the entities referred to in paragraph 9, first period
- Specifications of the service and management characteristics

Administrative Documents

The proposal must also be accompanied by the following administrative documents:

- Self-certifications of compliance with the requirements in paragraph 17
- A security deposit as per Article 103
- A commitment to provide a security deposit of the amount mentioned in paragraph 9, third period, if the proposal advances to a tender phase

Evaluation Process

The procedure, from the submission of the proposal to the signing of the contract with the winning bidder, is well defined, ensuring the smooth progression of the operation if followed correctly:

a) The administration reviews the proposal's feasibility within a three-month deadline. The contracting authority may request modifications to the feasibility project. If the proposer fails to comply, the proposal will not be evaluated positively.

b) The modified feasibility project is integrated into the programming tools approved by the contracting authority and submitted for approval. If additional changes are requested during this phase and not implemented, the project will be considered disapproved.

c) The approved feasibility project then forms the basis for a public tender in which the proposer and other interested parties may participate. The contracting authority may request the submission of project variants during the tender process.

Race phase

Competitors, including the original proposer, must:

- Fulfil the requirements of paragraph 8
- Submit an offer that includes:
  - A draft agreement
  - An economic-financial plan certified by one of the entities mentioned in paragraph 9, first period
  - Specifications of service and management characteristics, along with any variants to the feasibility project, in compliance with paragraphs 4, 5, 6, 7, and 13

If the proposer is not the winning bidder, they have the right of first refusal within fifteen days of the award notice. They may become the successful bidder if they agree to fulfil the contractual obligations under the same terms as the original awardee.

If the proposer does not exercise the right of first refusal, they are entitled to reimbursement for the costs of preparing the proposal, within the limits specified in paragraph 9, from the successful bidder. Conversely, if the proposer exercises the right of first refusal, the original successful bidder is entitled to reimbursement for the costs of preparing their offer, also within the limits specified in paragraph 9.

VII.1.5. Bank Loans as a Project Financing Mechanism

For this Renewable Energy Community (REC) project, the total investment is €620,000, with €520,000 financed through a bank loan and €100,000 contributed by the company. This financing structure allows the project to begin without a substantial upfront capital contribution from the developer, with the loan repaid over the project’s 12-year lifespan.

By opting for this financing model, the financial burden is spread over the project's operational life, ensuring that cash inflows from energy sales and incentives align with the outflows required for loan servicing. Furthermore, the project operates under the provisions of **Article 183 of Legislative Decree No. 50/2016,** which emphasizes maintaining "*economic and financial balance*." This principle ensures that the project generates sufficient revenue to cover both operational expenses and loan repayments. The financial structure is designed to guarantee adequate cash flow to meet debt obligations and achieve profitability targets, thus ensuring long-term sustainability and compliance with legal requirements.

Bank loans are a common mechanism for financing large-scale infrastructure projects, such as this Renewable Energy Community (REC). In project financing, loans are typically secured based on the future cash flows the project is expected to generate, rather than the borrower's assets. In this case, €520,000 of the total project cost will be financed through a bank loan, making it the primary source of funding for the development.

One significant advantage of using a bank loan for project financing is that it allows the project to proceed without requiring the developers to provide the full capital upfront. The loan repayment schedule is distributed over the project's lifespan, which, in this case, is 12 years. This structure is particularly well-suited to renewable energy projects, which generally produce stable and predictable cash flows over time from energy sales and incentives. These cash flows form the basis for repaying the loan.

In this model, the bank evaluates the project's capacity to generate sufficient revenue over its operational life to meet both interest and principal payments. Thus, the project's financial sustainability is crucial, as the bank's main concern is ensuring that the loan will be repaid from the project's income. To mitigate risk, banks often require detailed financial models and projections demonstrating that the project will generate adequate cash flow for loan servicing.

Additionally, bank loans in project financing are typically non-recourse, meaning that if the project fails to generate sufficient income, the bank's recourse is limited to the project's assets and cash flows rather than the developer's personal assets. This structure is particularly advantageous to developers, as it limits their personal financial risk while still allowing them to access significant capital.

VII.1.6. Recovery of Investment through Availability Fee

The investment recovery for this renewable energy community project is structured through an Availability Fee. This fee is a financial mechanism that ensures consistent cash flows to cover operational costs and repay the bank loan over the project's 12-year lifespan. The Availability Fee is particularly beneficial in ensuring the financial sustainability of the investment by aligning payments with the project's operational performance and revenue generation.

Key Components of the Availability Fee:

1. **Fixed Compensation for Photovoltaic (PV) System Availability**: This is a guaranteed payment from the administration or governing body to ensure the photovoltaic system's availability. It provides a steady income stream to the project, even when energy production fluctuates due to external factors such as weather conditions. This stability is crucial for covering fixed costs and servicing the loan.

2. **Revenue from Energy Sales to the Grid**: A portion of the project's income is derived from selling the electricity generated by the solar panels to the grid. This revenue stream is variable and depends on energy production levels, electricity prices, and market demand. However, it plays a critical role in generating cash flow to support loan repayments and operational expenses.

3. **Government Incentives**: Renewable energy projects often benefit from government or regional incentives designed to promote clean energy production. In this case, part of the project's revenue will come from these incentives, which may include subsidies, tax credits, or feed-in tariffs. Such incentives enhance the project's financial viability by supplementing revenue and reducing reliance solely on energy sales.

Role of the Availability Fee in Financial Sustainability:

The Availability Fee ensures that the project generates enough revenue to cover operating expenses and meet debt obligations. This structured approach aims to maintain the project's Net Present Value (NPV) at zero by the end of the 12-year lifespan. An NPV of zero indicates that the project has recovered all its costs without generating excess profits or losses, fulfilling the economic and financial equilibrium requirements outlined by Italian law.

VII.2. Economical approach of Life Cycle Cost (LCC) Analysis

VII.2.1. Life-Cycle Cost Analyses LCCA

A key consideration in any renewable energy community project is its design. The project's sustainability, environmental friendliness, and economic viability are essential factors. Additionally, the construction phase raises questions about how the project will be built and at what cost.

Another critical aspect is the operational cost over the project's lifespan. Modern economic theory combined with technology enables a more comprehensive approach to project design and construction. Instead of focusing only on initial costs. Project owners can evaluate the total costs, including operation, maintenance, repairs, replacements, and disposal over the project's lifecycle. This total cost is called the **Life Cycle Cost (LCC)**.

According to the National Institute of Standards and Technology (NIST) Handbook 135(1996 edition), LCC refers to the total discounted dollar cost of owning, operating, maintaining, and disposing of a project over its life [43, p. 2]. Life Cycle Cost Analysis (LCCA) is a method used to determine the total cost of owning and operating a facility over a specific period.

Life cycle cost (LCC) analysis is an essential methodology in evaluating the total cost associated with a product, project, or system over its entire life span, unlike traditional cost assessments that only focus on initial investment or operational expenses, LCC provides a comprehensive economic evaluation, accounting for all costs from acquisition to disposal. This approach ensures that decision-makers can compare alternative solutions on a long-term financial basic, encouraging more sustainable and economically sound decisions. [44, p. 1.1]

VII.2.2. Concept and importance of LCC Analysis

LCC analysis aims to provide a holistic perspective on cost management by considering the total economic impact of a product or project throughout its life. The fundamental rational behind LCC is that a higher upfront cost may result in lower long-term expenses if it leads to more efficient operation, maintenance, or disposal.

Key benefits of adopting LCC analysis include:

- ***Informed Decision Making:*** *it allows stakeholders to understand the financial implications of different options over time.*
- ***Cost Efficiency:*** *LCC analysis helps in identifying the most cost-effective solutions by comparing the long-term benefits of alternatives.*

- ***Risk Mitigation:*** *By considering future costs, LCC helps to mitigate risks related to maintenance, operational inefficiencies, and unforeseen replacement expenses.*
- ***Sustainability:*** *The approach promotes investments in products or projects that have lower environmental and societal impacts over their lifespan.*

VII.2.3. Key Component of LCC Analysis

A comprehensive LCC analysis involves various cost components that contribute to the total cost throughout the lifecycle. These components typically include:

- ***Acquisition Costs:*** *the initial costs incurred to acquire, install, or implement the product or system. this includes procurement, delivery, and installation costs.*
- ***Operation and maintenance costs:*** *costs incurred during the operational phase, including energy consumption, labour, routine maintenance, and repair costs, these often constitute a significant portion of the total lifecycle cost.*
- ***Replacement and refurbishment costs:*** *over time, parts of system or equipment may need to be replaced or refurbished. This includes material, labour, and downtime costs associated with such activities.*
- ***End of life costs:*** *the costs associated with dismantling, recycling, or safely disposing of the system or product at the end of its life cycle. In some cases, there may be residual value, such as recycling income, which can offset these costs.*
- ***Financing costs:*** *interest, loan, fees, or other costs related to financing the initial acquisition or subsequent upgrades can also be factored into the analysis.*
- ***Environmental and societal costs:*** *for a broader analysis, it is important to include externalities such as environmental impacts, carbon footprint, and societal costs. these often influence regulatory and public decisions, especially in industries with heavy environmental regulation.*

VII.2.4. Methodology for LCC Analysis

The step-by-step process for conducting LCC analysis includes:

1. ***Define scope and Objectives:*** *Clarify the product, system, or project being analysed and identify alternatives. Set boundaries for the study in term of time horizon, cost categories, and relevant performance criteria.*

2. ***Identify cost component:*** *Break down the product or system into its cost components, ensuring that all phases (acquisition, operation, maintenance, disposal) are included.*
3. ***Estimate cost over time:*** *for each component, estimate the cost throughout the product's lifetime. This may include inflammation adjustments, tax considerations, and potential subsidies.*
4. ***Calculate net present values (NPV):*** *Since LCC typically involves costs spread over several years, it is important to discount future costs to their value using a discount rate. This ensures that future expenditures are valued consistently with current expenditures.*

$$NPV = \Sigma \frac{c_t}{(1+r)^t}$$

Where:

- C_t *is the cost at time t,*
- *r is the discount rate,*
- *t is the time.*

5. ***Perform Sensitivity Analysis:*** *Examine how changes in key variables (e.g., discount rate lifespan of the product) affect the total LCC. Sensitivity analysis provides insight into potential risks and the robustness of the decision.*
6. ***Compare alternatives:*** *the final step is to compare the total LCC of various alternatives. This comparison should highlight the economic efficiency of each option and may include additional qualitative factors such as environmental impact of societal benefits.*

VII.2.5. Application of the LCC analysis

LCC analysis is widely applied across various industries and sectors. Some key area of application include:

- ***Infrastructure and construction:*** *LCC is used in construction to evaluate the total cost of building materials, labour, and long-term maintenance. Sustainable* *construction materials with lower operational costs are favoured, even if their initial costs are higher.*

- ***Manufacturing and industry:*** *LCC is applied in the manufacturing sector to optimize the procurement of machinery and equipment. High-efficiency machines with a lower operational footprint can lead to significant cost savings.*
- ***Energy sector:*** *in the energy sector, LCC is used to evaluate the total cost of energy generation technologies (e.g., solar, wind, coal, nuclear). Renewable energy sources, though often having higher initial costs, tend to be favoured in LCC analysis due to their lower operational and environmental costs.*
- ***Public projects and policy:*** *Government use LCC analysis to assess long-term fiscal impacts and societal benefits of projects like highways, public transportation systems, and waste management facilities.*

VII.2.6. Challenges and limitations of LCC Analysis

Life Cycle Cost (LCC) Analysis, while valuable, comes with several challenges and limitations. One major issue is data uncertainty, as obtaining accurate and reliable data for long-term costs, such as maintenance, replacement, and disposal, can be difficult. Changing technology and evolving regulations further complicate LCC projections, as innovations or new laws may render initial estimates obsolete. Additionally, the selection of a discount rate and time horizon introduce subjectivity, as these factors significantly influence the outcome. This means that, without careful consideration, the results of an LCC analysis may lead to biased or inaccurate conclusions. Despite these challenges, LCC remains a powerful tool for evaluating long-term cost implications.

VII.3. Capital Expenditures & Operational Expenditures

The investment for this project will be financed through **Project Financing** via bank loans. This means that the total investment is recovered through an Availability Fee, which includes general compensation for PV availability to the administration, a percentage of energy sold to the grid, and a percentage derived from incentives.

The total plant investment, which includes costs for 906 photovoltaic modules, carport structures, aluminium frames, inverters, cabling, and other essential components, is estimated at **€580,000**. Additionally, the investment for the network manager is **€25,000**, and the cost for establishing the Renewable Energy Community is **€15,000**, based on figures from the Ancona Chamber of Commerce Webinar. This brings the total **CAPEX (Capital Expenditure)** for the project to **€620,000**.

The maintenance cost, which remains constant throughout the project's lifespan, has also been considered. An annual fixed maintenance cost of **€6,500** has been determined by multiplying the unit maintenance cost by the total system power. Additional data is presented in the following tables.

$$\boldsymbol{maintenance\ cost}\ (€) = \boldsymbol{unit\ coast}\left(\frac{€}{\boldsymbol{kWp}}\right) \times \boldsymbol{totalsystem\ power}\ (\boldsymbol{kWp})$$

CAPEX		
Plant Investment	**€**	**580 000**
Network manager Investment	**€**	**25 000**
REC creation	**€**	**15 000**
total	**€**	**620 000**

OPEX		
Maintenance	**€/year**	**6 500**

Table 15:summary of both CAPEX (Capital Expenditures) and OPEX

ID -	Name / site	System Power kWp	PLANT INVESTMENT							
			Modules €	Aluminium Structures €	Carport Structures €	Modules Optimizers €	Inverter €	Cables Panels €	Installation (Carport + Plant) €	
1	**Sant' Ippolito Cemetery**	19,32	4 012,7	2 006,3	0,0	1 280,0	1 600,0	1 337,6	213,3	396,4
2	**Pian Di Rose Primary School Parking**	79,65	16 542.9	8 271.5	60 782,0	5 120,0	6 400,0	5 514,3	879,3	1 634,2
3	**Pian Di Rose Primary School**	26,10	5 420,8	2 710,4	0,0	1 600,0	2 000,0	1 806,9	288,1	535,5
4	**Sant Ippolito Evolution Camp**	83,70	17 384,1	8 692,0	63 872,7	5 280,0	6 600,0	5 794,7	924,0	1 717,3
5	**shopping centre San. Vincenzo Parking**	126,90	26 356,5	13 178,3	96 839,2	1 280,0	1 600,0	8 785,5	1 401,0	2 603,7
6	**Pian di rose school walkway**	73,35	15 234,4	7 617,2	55 974,4	4 800,0	6 000,0	5 078,1	809,8	1 505,0
	Total from %		**84 952**	**42 476**	**277 468,3**	**19 360,0**	**70 793**	**28 317,17**	**42 475,76**	
	Total investment €									**565 841.4**
	Total investment €/kWp									**1383.4**
	ENGINEERING									**14159**
	Total									**580 000.0**

Table 16:Summary of Plant Investment across all project sites

The availability fee that the company receives from the Public Administration amounts to **€78,000**, while the revenue for the Public Administration is approximately **€12,751**. These results were calculated using the following mathematical formula:

$$\boldsymbol{Concessionaire\ Revenue} = (\boldsymbol{SSc} \times \%\boldsymbol{Sc}) + (\boldsymbol{RS} \times \%\boldsymbol{S}) + (\boldsymbol{VSNC} \times \%\boldsymbol{C}) + (\boldsymbol{RI} \times \%\boldsymbol{I})$$

$$\boldsymbol{Revenue\ Manager} = (\boldsymbol{SSc} \times \%\boldsymbol{Sc}) + (\boldsymbol{RS} \times \%\boldsymbol{S}) + (\boldsymbol{VSNC} \times \boldsymbol{RNC}) + (\boldsymbol{RI} \times \%\boldsymbol{I})$$

$$\boldsymbol{Revenue\ Administration} = (\boldsymbol{SSc} \times \%\boldsymbol{Sc}) + (\boldsymbol{RS} \times \%\boldsymbol{S}) + (\boldsymbol{VSNC} \times \%\boldsymbol{C}) + (\boldsymbol{RI} \times \%\boldsymbol{I})$$

$$\boldsymbol{REC\ Revenue} = (\boldsymbol{SSc} + \boldsymbol{RS} + \boldsymbol{RNC} + \boldsymbol{RI}) - (\boldsymbol{RM} + \boldsymbol{CR} + \boldsymbol{RA})$$

SSc: Savings Self-consumption	**%C: percentage of Network Charges**
%Sc: percentage Self-consumption	**RI: Revenue Incentive**
RS: Revenue Sale	**%I: percentage of Incentive**
%S: percentage of Sale	**RNC: Revenue Network charges**
VSNC: Variable Share Network Charges	

REVENUE FROM REC		
Revenue Manager	€/year	**9 064**
Concessionaire Revenue	€/year	**68 936**
REC revenue	€/year	**12 751**

Table 17: revenue from the renewable energy community.

Purchase value electricity €/kWh	Savings Self-consumption €	Unit Value of Energy Produced (PUN) €/kWh	Revenue Sale €	Variable share Network charges c€/kWh	Revenue Network charges €	CER Production Incentive c€/kWh	Revenue Incentive €
0.23	**272,93**	**0,09**	**40 339,65**	**1,057**	**12,54**	**11,40**	**50 167,28**

Percentages				Manager Revenue
Self-consumption	**Sale**	**Charges**	**Incentive**	
%	**%**	**%**	**%**	
0	**0.10**	**0.00**	**0.10**	**9063.95**

Percentages				Concessionaire Revenue
Self-consumption	**Sale**	**Charges**	**Incentive**	
%	**%**	**%**	**%**	
0.85	**0.75**	**0**	**0.77**	**68936.05**

Percentages				Revenue Administration	REC revenue
Self-consumption	**Sale**	**Charges**	**Incentive**		
%	**%**	**%**	**%**		
0.15	**0**	**0**	**0**	**40.94**	**12751.47**

Table 18:availability fee calculation

Concession revenue composition								
self-consumption			**Sale to the GSE**			**Production incentive**		
%	€	€	%	€	€	%	€	€
	Savings Self-consumption	85% of Savings Self-consumption		Revenue Sale	75%of Revenue Sale		Revenue Incentive	75% of Revenue Incentive
0,85	272.93	**232**	0,75	40 339,65	**30 255**	0,75	50 167,28	**37 625**

Table 19:breakdown of revenue from a concession in three categories

ANNUAL ELECTRICITY CONSUMPTION AND PRODUCTION		
Total electricity consumption	kWh	1 581 000
System power	kWp	409,02
Maximum PV system power		409,02
Installation area	-	CNOR
Average production hours	h	1099
Annual PV production	kWh	449 405
Estimated physical self-consumption	kWh	1 187
Production fed into the grid	kWh	448 218
Energy injected and shared virtually	kWh	440 064
ENERGY AND ENVIRONMENTAL INDICATORS		
Physical self-consumption index	%	0,26
Virtual self-consumption index	**%**	97,92
Total self-consumption index	%	98,19
energy self-sufficiency index	%	27,91
CO2 avoided by 1 kWhe	kg/kWh	0,530
Tonnellate di CO2 annuale evitata	tCO2	233,23
PARAMETRI ECONOMICI SULLA FORNITURA ENERGIA		
Unit value of energy produced (PUN)	€/kWh	0,090
Sales value	€/kWh	0,108
Electricity purchase value	€/kWh	0,230
Variable share of network charges	c€/kWh	1,057
ENERGY COMMUNITY INCENTIVE CALCULATION		
Zonal hourly price	€/MWh	116,64
Calculated premium rate - TIP	€/MWh	110,00
Tariff correction	€/MWh	4,00
Unit value of production incentive	c€/kWh	11,40
Unit cost of PV system	€/kWp	1418
Unit maintenance cost	€/kWp	17,11407755
Plant tax deduction	SI/NO	NO
Total tax deduction	%	50
Years deduction	-	10

Table 20:Energy community dashboard

Energy production varies significantly throughout the year, while self-consumption _energy directly used by the prosumer (producer and consumer) _ remains relatively constant. Most of the energy produced is injected into the grid and sold. For most of the year, production generally aligns with demand. However, during the winter months, a significant gap between production and demand emerges, particularly for consumers, indicating reliance on external energy sources to cover the shortfall. In contrast, during the summer, the community likely generates a surplus of energy, offering opportunities for energy storage or feeding excess energy into the grid to optimize usage.

Steady consumption among prosumers reflects a balanced energy usage pattern within this group, though there may be potential for efficiency improvements or energy sharing to better manage excess PV production.

This analysis underscores the importance of balancing energy production, storage, and distribution, particularly for a community dependent on renewable sources like photovoltaics. Addressing seasonal variability through enhanced energy management systems or supplemental energy sources during low-production periods is crucial. Additional details are illustrated in the following table and chart.

Name / site	Production PV kWh	Consumption Prosumers	Self consumption physicist kWh	Percentage Input	Energy entered network kWh	Request Consumer	Self consumption Virtual kWh	Self consumption Virtual kWh
MONTHLY PERFORMANCE SUMMARY								
January	12 805	170	170	98,68%	12 635	73 547	12 635	100%
February	19 186	113	113	99,41%	19 073	66 128	19 073	100%
March	33 446	119	119	99,65%	33 327	67 134	33 327	100%
April	46 966	90	90	99,81%	46 876	60 177	46 876	100%
May	62 385	90	90	99,86%	62 295	63 565	62 295	100%
June	62 783	57	57	99,91%	62 726	62 567	62 567	100%
July	68 240	34	34	99,95%	68 206	61 999	61 999	91%
Agosto	55 933	34	34	99,94%	55 899	54 111	54 111	97%
Settembre	37 491	40	40	99,89%	37 451	59 170	37 451	100%
October	24 109	124	124	99,48%	23 985	64 501	23 985	100%
Novembre	14 657	147	147	99,00%	14 510	68 573	14 510	100%
Decembre	11 404	170	170	98,51%	11 234	74 027	11 234	100%
TOTAL	449 405	1187	1187	99,51%	448 218	775 500	440 064	

Table 21:monthly performance summary

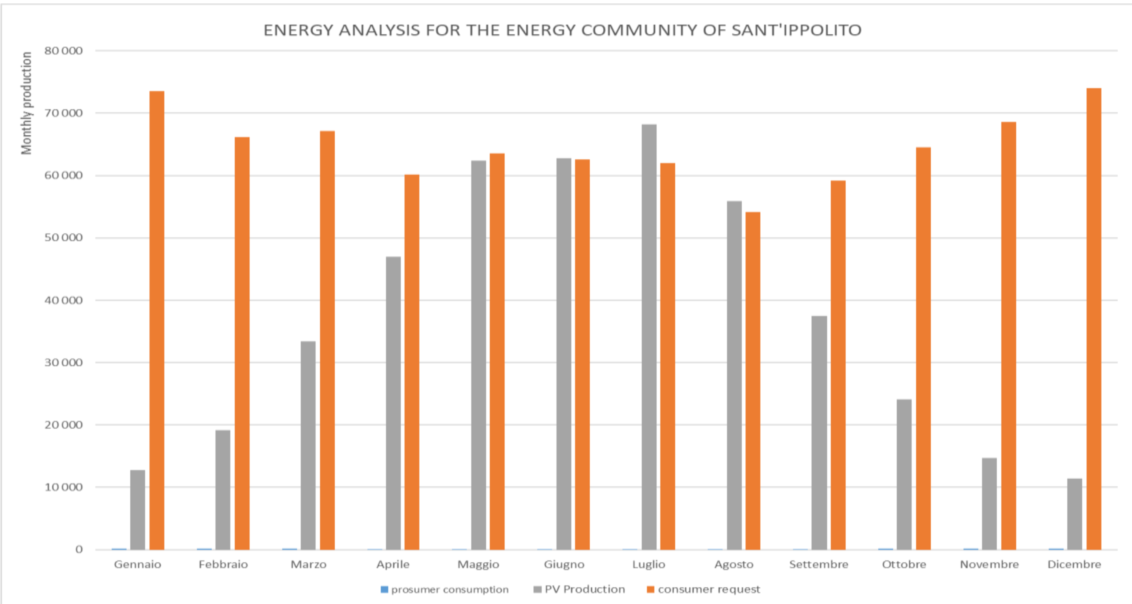


Figure 45:Energy Analysis for the Energy Community

XII.1.1. Plant construction and management

A life cycle coast analysis LCCA study is made to analyse the project for his lifespan, two alternative was taking in consideration an investment with the bank loan and the investment without, with two different economical key performance indicator (KPI), a quantifiable measure of performance over time and other economic and technical parameter are illustrated in the following tables

CAPEX		
AGRIVOLTAIC & GENERAL ASSETS	620 000	€
0,00	0	€
CULTURAL SYSTEMS & IRRIGATION COSTS	0	€
GENERAL AGRICULTURAL EQUIPMENT	0	€
		€
TOTAL	620 000	€
OPEX (MEDIUM)		
Operating costs	6 500	€/a
BUSINESS PLAN SUMMARY		
CAPEX	620 000	€
OPEX MEDIUM (Updated to 2026)	6 376	€/a
RICAVI MEDIUM (Updated to 2026)	76 507	€/a
Recovery Costs	0	€
Recovery Costs at Timing Life	0,00	€
System Residual Value	0	€
System Residual Value at Timing Life	0,00	€

Table 22:economical parameter

ECONOMIC KPI - CASE WITHOUT FINANCING	
NPV (Net Present Value)	€ 141 168
IP (Profit Index)	0,2
TRA (Discounted Return Time)	9,00
IRR (Discounted Internal Rate of Return)	5,16%
ECONOMIC KPI - CASE WITH FINANCING	
VAM (Modified Net Present Value)	€ 1 758
IP (Profit Index)	0,0
TRA (Discounted Return Time)	11,0
IRR (Discounted Internal Rate of Return)	

Table 23:KPI parameter with and without financing

ECONOMIC PARAMETERS	
Discount Rate/WACC	4,0%
Inflation	3,0%
Include Tax Charge	SI
Depreciation (It is only considered if tax is included)	10%
Choice INVESTMENT CASE	REC with incentives
TECHNICAL PARAMETERS	
Investment Analysis Time/Timing Life	12,00 years
FINANCING	
Consider Financing	SI
Capital financed	84%
Annual Interest Rate (fixed)	5,00%
No. instalments per year	12
years	10
Capital financed	520 800€
NOTES	
DIRECT Energy Sale Price: €0.095/kWh	
Financial Plan Without TAXATION	

Table 24:economical, technical and financing parameters

This LCC Analysis looks at how the energy community project will perform financially over 12 years. Without financing, the project begins with a significant upfront cost of €620,000 in 2023, resulting in a negative cash flow. However, as the project progresses, cash inflows increase steadily each year. By 2033, the cumulative values turn positive, the project achieves cumulative positive cash flows of €141,167.73.

With financing, the project benefits from reduced initial financial strain, with a lower cash outflow of €99,200 in 2023. Although cash inflows are lower in the early years due to financing costs, the project reaches a cumulative positive value by 2035, two years earlier than the non-financed scenario, with final cumulative cash flow of €1,758.23.

both paths lead to a profitable outcome, the project with financing reaches financial sustainability earlier and faces less initial financial pressure.

ECONOMIC ANALYSIS				
PROJECT CASE				
	WITHOUT FINANCING		WITH FINANCING	
y	CASH FLOWS	CUMULATIVE VALUES	CASH FLOWS	CUMULATIVE VALUES
2023	-€ 620 000,00	-€ 620 000,00	-€ 99 200,00	-€ 99 200,00
2024	€ 68 337,31	-€ 551 662,69	€ 5 460,21	-€ 93 739,79
2025	€ 68 180,02	-€ 483 482,67	€ 5 302,93	-€ 88 436,86
2026	€ 67 667,52	-€ 415 815,14	€ 4 790,43	-€ 83 646,43
2027	€ 67 159,95	-€ 348 655,19	€ 4 282,86	-€ 79 363,57
2028	€ 66 657,26	-€ 281 997,93	€ 3 780,16	-€ 75 583,41
2029	€ 66 159,40	-€ 215 838,53	€ 3 282,31	-€ 72 301,10
2030	€ 65 666,33	-€ 150 172,20	€ 2 789,23	-€ 69 511,87
2031	€ 65 178,00	-€ 84 994,20	€ 2 300,90	-€ 67 210,96
2032	€ 64 694,37	-€ 20 299,84	€ 1 817,27	-€ 65 393,69
2033	€ 64 215,38	€ 43 915,54	€ 1 338,29	-€ 64 055,41
2034	€ 48 861,00	€ 92 776,55	€ 17 422,45	-€ 46 632,95
2035	€ 48 391,19	€ 141 167,73	€ 48 391,19	€ 1 758,23
TOT	**€ 141 167,73**		**€ 1 758,23**	

Table 25:economic analysis

XIII.1.1.1. Final Considerations

Financing helps reduce the initial financial burden by covering upfront costs, allowing the project to become profitable faster and lowering short-term risks. This aspect is particularly appealing to investors who prefer greater stability in the early stages. However, if the project does not utilize financing, it will take longer to recover the initial investment. This makes careful financial management crucial from the beginning for long-term success.

Overall, financing serves as an effective tool to alleviate early financial stress and create a smoother path to profitability, enhancing the project's attractiveness to stakeholders.

Ultimately, the project's success depends on consistent management and the maintenance of positive cash flows in later years.

Conclusion

The Renewable Energy Community (REC) project shows promising potential for both energy production and financial success. Throughout our analysis, we found several important points:

Energy Production:

The REC can generate a lot of renewable energy, especially during the summer months. However, there is a noticeable drop in energy production during the winter. This means that the community will need to find ways to meet energy needs during these colder months, possibly through energy storage systems or by buying energy from the grid.

Financial Stability:

Financially, the project is definitely sustainable over time. with investment payback times and rates of return in line with similar proposals related to energy efficiency. With financing, such as bank loans, the project reduces the initial credit burden, effectively lowering the initial financial commitment of the proposer but at the same time reducing the initial revenues. In this case the NPV, as required by the proposals for public-private partnerships, tends to zero, according to the principle of economic balance required by current legislation.

Attracting Investors:

Financing helps to ease early financial pressures, making the project more attractive to investors who prefer stability. The project can still succeed without financing, but it would take longer to recover initial investments.

Importance of Planning:

The REC project highlights the need for careful planning to manage energy production and finances. Solutions like energy storage or buying extra energy during low production periods will be important for maintaining energy supply.

In summary, the REC project is both technically and financially possible, offering long-term benefits to the community and investors. Success will depend on balancing energy production with demand, managing financial risks with the help of financing, and addressing energy shortages during winter months. The project represents a step toward a sustainable and independent energy future for the community while showing the importance of smart planning and financial management in renewable energy efforts.

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