PANNELLI SOCIALI

PROJECT TEAM
Paola Almeida Soares
Ottavia Belli
Luca Esposito
Elizabete P.S. Santos
Serena Piselli
Ambra Ruffini

TUTOR
Lucie Greyl

A Sud – Ecologia e Cooperazione ONLUS
www.asud.net

Rome, Italy, 2017

Erasmus+

Funded by the Erasmus+ Programme of the European Union.
The content of this document reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

PANNELLI SOCIALI

CSOA La Strada

The CSOA La Strada was born in 1994 from a university group of activists of the "Pantera" movement as a place where local people could join for a dance, watch the football match, for a theatre show or for some live music. During the end of the 90ies a new experience in the institutions started and the goal was to push the decision processes towards the bottom of the pyramid for real democracy; the Zapatista revolution, the no global movements, the right for a house. The "Agency Rights New Citizenship" was born from this experience in the institutions, it's a town counter that stimulates the territorial net and stimulates the citizens to defend their rights. During the 2000s the neighbourhood changed, the third university of the city was born in this area, the number of students rose and a large ethnical group moved in this area. The Agency took care of the afghan refugees at the Air Terminal, of the Moldavian community of Tor Marancia and in 2003 the project "Le Casette" started occupancy housing against the building speculation.

New projects started around the year 2000; the school "Scuola Popolare Piero Bruno" has the goal to fight early school leaving; the territorial newspaper C.O.R.E Circuiti Editoriali Resistenze Editoriali, dedicated to free and independent information ; the tavern-winery "Ardente"; the bicycle cooperative. This place was born as a social open space, antifascist and antiracist, a political laboratory for the young activists and for all those who want to stand up for a better and more social world.

With the territorial laboratory "Play" the association gained the largest number of preferences and managed to enter the institutions of the VIIIth town hall with an independent councillor. Today, in the days of the crisis, the CSOA does not resign to job insecurity and generational impoverishment; they believe that the possibility to build a better and more social future lies in the shared thought and cooperation.

Rome, a city that has been heavily hit by an economical, occupational, social, cultural and ethical crisis, has been unable to develop strategies to contain this dramatic situation. The association tries to build an alternative to the wrong development policies in the work field and for the companies that have been hit by the crisis, to the shoddy public services, to the job security and to the economy characterized by deep criminal infiltration.

The huge public patrimony of the city of Rome, that is often bestowed upon ad personam, poorly managed or abandoned, is the starting point for the urban regeneration so it can be returned to people, to culture, to sport, to start-ups and to coworking projects. The CSOA attempts to subtract whole areas from the decay and desertion with the aim to give them back to the city and to the citizens. This is why the CSOA has organized, over the years, the building of mutual relations for integration of young people in the working world, for a better approach to culture and for the school and civic mobilization of energies through many projects.

The CSOA La Strada is in the heart of Garbatella, the VIIIth city hall, a working class neighbourhood that was built in late 1920ies on the English urban model. Subsequently, during the fascist era, it became a reception area of many evacuees coming from the centre of Rome that were collocated in new big buildings that surround green yards and gardens that were haunts for the citizens.

The popular and rural aspects are accompanied by the architectural art movement called "barocchetto romano" that makes it one of the most unique and fascinating areas of Rome. The liveability and vitality of the area is perceivable also from the cultural ferment typical of the neighbourhood: this hosts many cultural-social centres like “Controchiave”, the theatre “Ambra alla Garbatella”, the “Palladium” theatre and many other associations that represent Gabriella’s soul.

From a political perspective Garbatella was and is nowadays a “red”, left-wing and working area; the resistance of the partisans found a wholehearted support here. In 1939, during the fascist era, the “new” neighbourhood was also destined to welcome numerous dispersed families after the flattening of all the buildings of the “Spina di Borgo” to create Via della Conciliazione in front of San Pietro (Saint Peter).

Garbatella is a neighbourhood that is predominantly housing, with various middle and primary schools, commercial activity like cafes, typical restaurants and some green zones of various dimensions: the “Commodilla” park, the “Cavallo Pazzo” park, the “Caduti a Mare” park, the “Garbatella” park, the “Caffarella” park and the “Tor Marancia” park.

The “Garbatella” park is the symbol of the tenacity and the commitment of Legambiente (an Italian environmental association) and of the citizens of the neighbourhood. Since 1996 people are working to retrain the area that has been used at first as a car deposit, then used by a circus, then as a car park for the Jubilee and finally it has been abandoned. After 10 years of struggle and bureaucracy fights this area has become public and it has been returned to the city and to the citizens. They have shown a strong interest for the realization of this green space where we can now find the “Garbatella urban gardens” which represent a social commitment and the desire of change. These urban gardens are also used for didactic purposes with the schools of the district. The “Garbatella park” also hosts a rose garden and a Japanese Zen garden in memory of the victims of Fukushima.

Another hopeful sign of peoples’ commitment and participation is the “Green Rome” project that has greened and improved the neighbourhood. Its purpose is to plant new trees along the sidewalks to improve the quality of the air and to give a more natural aspect to the area.

The regeneration project that we’ve undertaken takes place inside the building of the VIIIth town hall local market in Via Francesco Passino 24. Here were we can find the CSOA La Strada; the “Farmers’ Market” with 24 agricultural holdings from areas of Lazio region (also many holdings from the zones struck by the recent earthquakes) that sell seasonal fruit and vegetables; and the coworking area called “Millepiani Coworking”.

Our project includes the installation of solar panels and the realization of bicycle generators for and educational purpose. The solar panels will bring energy to the CSOA La Strada, to the market and to the coworking area and the bicycle generators will be used in all three spaces. This project wants to raise awareness of a responsible use of energy among people and thanks to the social commitment of the district population it will be possible to organize at the CSOA La Strada and at in the market some “energetic days” that aim to spread information on energy and renewable sources of energy. The involvement of the district and of the city in general is a primary objective for the diffusion of the knowledge among adults and children. These will have the possibility to "physically" try what means to produce energy, this will happen on the bike-generators and other typologies of bikes like the bike - blender. Our aim is to physically and emotionally involve the inhabitants of the district, which will be spurred to watch out for domestic consumption of energy as this is the greatest source of pollution nowadays.

The CSOA La Strada is a crucial knot of the district, a meeting point for many young people and adults that have grown in this district. Many people see this place as a second house but others have completed hostile actions against the organization, in particular two arsons have hit the building in December 2013 and have heavily damaged the structure. The CSOA LA Strada, the neighbourhood and the population haven't been intimidated by these provocations made by people that don't appreciate an antifascist centre. A fundraising project started and succeeded thanks to the participation of many people and of many other cultural centres of Rome. Solidarity and team work have given back life to a symbolic place of the district that continues to be a meeting and reference point for many.

This type of event gives us the awareness that everything can be done bottom-up and can also challenge those who try to destroy years of sacrifices, hard work and devotion to the population.

Participative method

The approach used for the participative process mainly focused on a strict collaboration with the main stakeholder and promoter of the project, the CSOA La Strada. In particular the people of the social centre gave us the possibility to visit the building, to make some measurement on the rooftop, and worked with us to estimate the energy consumption of the building. With their help we were able to select the ideal spaces to place the solar panels on, and to choose the right capacity for the solar plant. On February the 6th we were invited to participate to a CSOA La Strada meeting in which we had the opportunity to present the basic idea of the project, and to explain how we would wanted to proceed, in that occasion we came in contact with the people responsible of the bicycle workshop that seemed really interested in the bicycle-generators project and willing to cooperate for their construction. For what concerns the other two stakeholders in the building: the Millepiani coworking and the farmer's market, the participative process has only reached an informative level, however when we explained our idea and how we intended to realize it we got a positive feedback; we are planning to involve more those two stakeholders in a following phase of the project, using the already strengthened relation with the CSOA La Strada and the bicycle workshop.

TECHINACAL DESIGN

The historical core of Garbatella district is about 85 years old, for its architectural features and the unity of the intervention, the district has now acquired its historical value. "The King Vittorio Emanuele II" hand laid the foundation stone of this district, as stated in the epigraph on the building of walled central Piazza Benedetto Brin, the first nucleus of the new township. Until then the area was made up of vast land holdings, concentrated in the hands of a few wealthy families who occupied houses and villas. Some arboreal, many reeds, various gardens and ruins in the distance dotted a Roman countryside. Garbatella developed around the ancient street "via delle sette chiese".Built from 1920 until 1922 by the initiative of the Institute public housing, on a hill adjacent to the basilica of St. Paul, near the railway line between Rome and Ostia, it was an example of garden-city. The residential matched the agriculture: each resident had his own vegetable garden to cultivate. The district was born as a settlement for worker at the industrial area, but also as a fishing village at the service of a left-wide river port project.

GENERAL DESCRIPTION OF THE BUILDING

The building has a particular shape connected to its positioning in a trapezoidal plot of land, with a difference in height between the front and rear area of about m 4.00; the sales floor is almost coplanar with the rear area, while on the main front arises at about 4.50 m from the road surface to which it is connected by stairways and ramps. The market is set on two levels, a ground floor dedicated to the sale and a basement, plus the coverage plan.

The central part has only one level, used as a market; the two lateral wings and the area behind mail hinge between the two rectangular bodies, constitutes the basement level: the ends of the wings is used in its entirety, on the east side as a social center and on the west side as a local Town Hall, called Urban Center , a service center for local development, expected within the district contracts as a meeting place and reference for the quarter, while the hinge area would the merchants storehouse. In the hinge area there are environments with storage function and local caissons, which are accessible only from the cover.

The building is one of the neighborhood's references to both functions housing, which for its architecture; building interpenetrate linear and curved surfaces determining a volumetric complexity that is emphasized by natural light: the shell, set on different levels tapered upwards, have allowed the insertion of strip windows at different heights which confer a level of diffuse brightness.

These conditions had to assume the public opening of the covering terraces, trying to make accessible the first level directly from the outside, taking advantage of the gap via Montuori.

The building structure is made partly in bricks and partly in concrete- central pillars of the underground and the sales floor and horizontal- and shows signs of a non-unitary design. In the central part of the building in c.a the pillars are set on plinths which rest on poles; the perimeter pillars are placed in the tiling of the floors bulkhead of the two underground wings made of reinforced concrete ribs with a distance of approximately 1.20 m.

TECHNICAL DESCRIPTION OF THE REGENERATION PROJECT

Describe the urban/architectural/engineering/morphological _ geological (for outdoor spaces) characteristics of the space where the regeneration is planned.

Describe the technical details of the regeneration intervention planned in your project proposal: urban aspects, engineering aspects and architectural aspects.

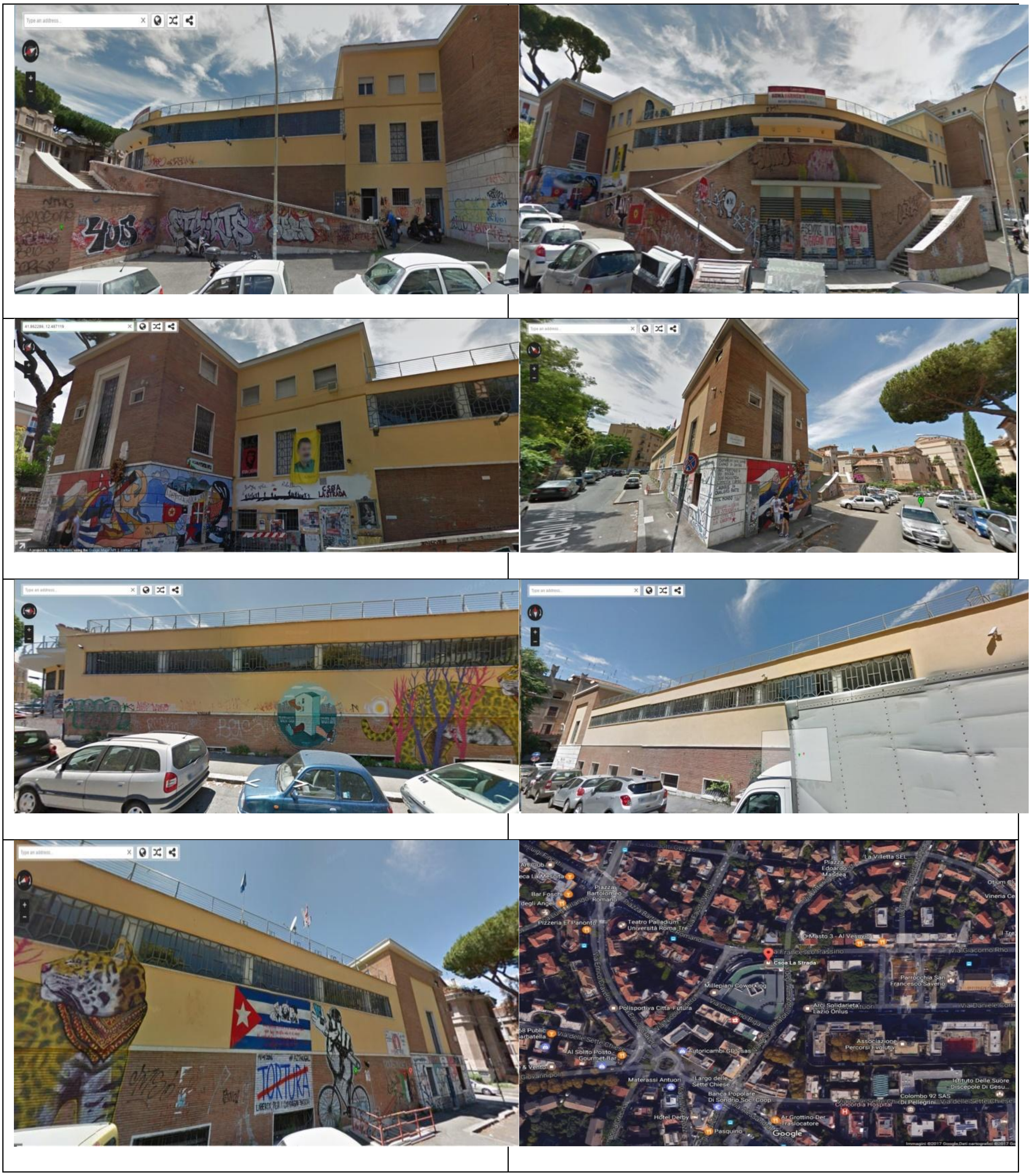
Taking in consideration the current energy consumption of La Strada Social Center, Farmers Market and the Coworking center, the regeneration proposal aims to install solar panels on the roof of the building to reduce the electrical energy consume supplied by the public utility. With this action, is possible to introduce a sustainable energy generation at the building and employ an unusable place.

Address: Via Francesco Passino, 24, 00154 Roma

Coordinate: 41°51'44.2"N 12°29'13.6"E

41.862286, 12.487119

Figure 1: Building locus



According to Nasa data base at Swera, an internet application available at https://maps.nrel.gov/swera, the daily values of the global horizontal irradiance, which means, the solar irradiation over the building area corresponds to 4,65 kWh/square meters, as is showed at Table 1.0.

Annual	Avg GHI	4.65
kWh/m sq, a day		
Jan	Avg GHI:	1.98
Feb	Avg GHI:	2.92
Mar	Avg GHI:	4.32
Apr	Avg GHI:	5.48
May	Avg GHI:	6.78
Jun	Avg GHI:	7.64
Jul	Avg GHI:	7.67
Aug	Avg GHI:	6.71
Sep	Avg GHI:	5.08
Oct	Avg GHI:	3.4
Nov	Avg GHI:	2.11
Dic	Avg GHI:	1.69

Table 1.0 Average global irradiance

With a large flat surface area available, in an area with high sun incidence, the building offers a great potential to produce solar energy.

The regeneration project prevails the installation of a photovoltaic plant able to produce up to 50kW peak energy. This value would be sufficient to source the equipment current in use at the building (estimated value considering the charge demand). That estimation in not exactly precise because of the no definition of every equipment present in the building.

The total energy production of the photovoltaic system depends directly and specially of the meteorological conditions of the area. Considering an ideal situation, at a sunny day with no clouds, the photovoltaic system is able to produce 180kWh. However, to achieve a maximum efficiency, the solar panels have to be installed with a South orientation, with an angle correspondent to the latitude of 41, 86.

SPECIFICHE TECNICHE PANNELLI

The photovoltaic panels have been taking in consideration for having a small dimension and a high efficiency. Compared to the other options available in the European market, the HIT® Panasonic VBHN330SJ47 photovoltaic module , is a better option for being able to achieve 19,7%, of efficiency even with small dimension. In an optimum situation, this photovoltaic module is able to supply 330Kwp. Also, it presents a 10 per cent positive tolerance. That means, the power supply can surpass the 330W in 10 per cent of this value, arriving at (330 + 33)W at a sunny day.

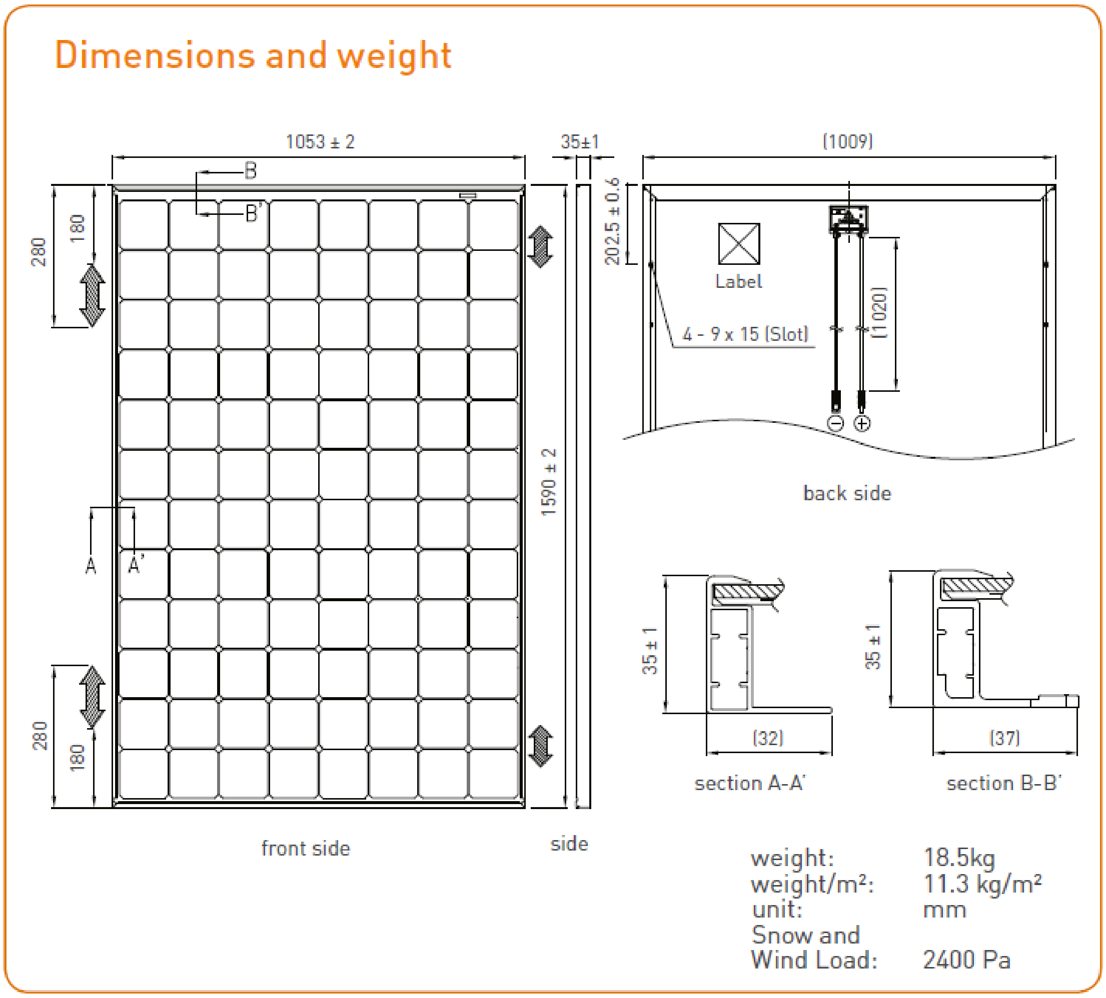
Considering a power demands of 50Kwp, are necessary 152 photovoltaic modules. However, for design issues, it can be used 156, producing 51,5kWp.

HIT® Panasonic VBHN330SJ47 photovoltaic module characteristics

Photovoltaic module	HIT 330W
Brand	Panasonic Sanyo
Max. power voltage (Vmp) [V]	330W
Open circuit voltage (Voc) [V]	69,7
Short circuit current (Isc) [A]	6,07
Max. power current (Imp) [A]	5.70
Max. power voltage (Vmp) [V]	58
Temp. coefficient of Voc [V/°C]	-0,174
Solar Panel efficiency	0,197
Power tolerance [%]	0/+10%
Temperature (NOCT) [°C]	44C
weight: (Kg)	19
Dimension (mm)	1053 x 1590
Surface (m2)	1,67
Glass material	AR coated tempered glass
Frame materials:	Black anodized aluminium
Resistency against Wind and snow	2400Pa
Product workmanship Guarantee	15 anni
Power output Guarantee	10 years (90% of Pmin) and 25 years (80% of Pmin)
Price	429 Euros
Other powers (W):	325W

Table 1.1 HIT® Panasonic VBHN330SJ47 photovoltaic module

In that project, the photovoltaic modules will be allocated on the roof of the building, oriented in the South direction and respecting a distance of 3.5 meters to avoid shadowing.



The electrical energy provided from the panels is a direct current (DC). On the other hands, all the electric and electronic devices in use at the building have to be source with Alternate Current (AC). In that way, is fundamental the use of an inverter to transform the DC in AC current. The FRONIUS SYMO 4.5-3-M inverter has been chosen to do this job. This inverter will be also responsible for connecting the module's strings to the electrical utility of the area and to the electrical system of the building, turning the project in an on-grid system.

The FRONIUS SYMO 4.5-3-M is a triphasic inverter without transformer with a 4.5kW power standard. The maximum voltage is 1kV and double MPPT to permit more configuration flexibility for the system. Moreover, the inverter has an interface that permits the internet connection through WLAN or Ethernet and it allows easy integration with diverse components. That hardware also allows a better control of the electrical energy production of the system and the possibility of upgrading it by developing an energy efficiency integrated system.

Describe the steps for the implementation of the regeneration intervention planned and the tools/instruments/machines/materials/competences and workers needed.

The first step for developing the project was the inspection of the building, on 12/21/16, to check the conditions of the area and to certify that it could be an appropriated place to install a photovoltaic system. On 12/19/16, the stakeholder/client La Strada, informed the estimated quantity of electrical and electronic devices in use at the social center and its power. That group of information were important to start estimating the amount of energy the place may needs, once it wasn't possible to have the previous energy billing to check it more accurately. On 01/14/17 the team went inside the building to verify the total charge demands of the Farmers' Market. On that day, it was clear that the total charge demands of the whole market was over the installed power. For that reason, it already happened some incidences of voltage drops.

As the informed data of charge demands were not completed, we made a table with an estimation of the total charge demand of the building considering the devices that are in use at the building:

Charge Demands					
Activity	Multiple				
Supply Voltage	220V				
Description	Active power	Quantity	Total Power	Place	Verage time of use
Frige	300	20	6000	Mercato	6
Beer Tap	700	1	700	CSOA	3
Lights	100	30	3000	Mercato	8
Frige	300	2	6000	CSOA	24
Lights	70	30	2100	Coworking	8
Cell Fridge	1260	1	1260	Mercato	24
Electric oven	2300	1	2300	CSOA	2
Lights system for concert	1500	2	3000	CSOA	occasionale
Sound system for concert	10000	1	10000	CSOA	Occasionale

Computers	100	10	1000	CSOA	8
Microwaves	1000	2	2000	CSOA	8
Computers	100	10	1000	Coworking	8
Printers	372	5	1860	Coworking	8
Total installed power 29420W Obs: Many activities take place at the building, with an irregular frequency. The table does not include the heater system, EVAC, air conditioning and other electronic and electronic appliances that were not clearly informed from the client.					
Supply Voltage: Characteristics		220V/50Hz Alternate Current			

The total energy demands of the building can be 50kwp (as informed by technicians at the Farmer's Market on the 01/14/17), if we consider all the devices above mentioned and others not informed from the client.

SCALABLE SYSTEM

The base project preview an energy production of up to 51,5kwp. However, it is possible to install the system in an scalable way.

Each photovoltaic module VBHN330SJ47 can produce 330W, while in open circuit, it means, when not in production , can have a maximum output voltage of 69.7V. The FRONIUS SYMO 4.5-3-M inverter have a maximum output power of 4.5kwp and admits a maximum 1kV string voltage. Therefore, considering the extreme conditions, of maximum input voltage (a really cold day, with no sun) or maximum output voltage, it can be connected 13 photovoltaic modules in series. For a 51,5kWp system, are necessary 12 strings with 13 modules each one. As a string has a power of up to 4,3kW, the installation of the modules can be done segregated, starting with a minimum one string and including groups of strings as it becomes necessary to arrive to the needed power.

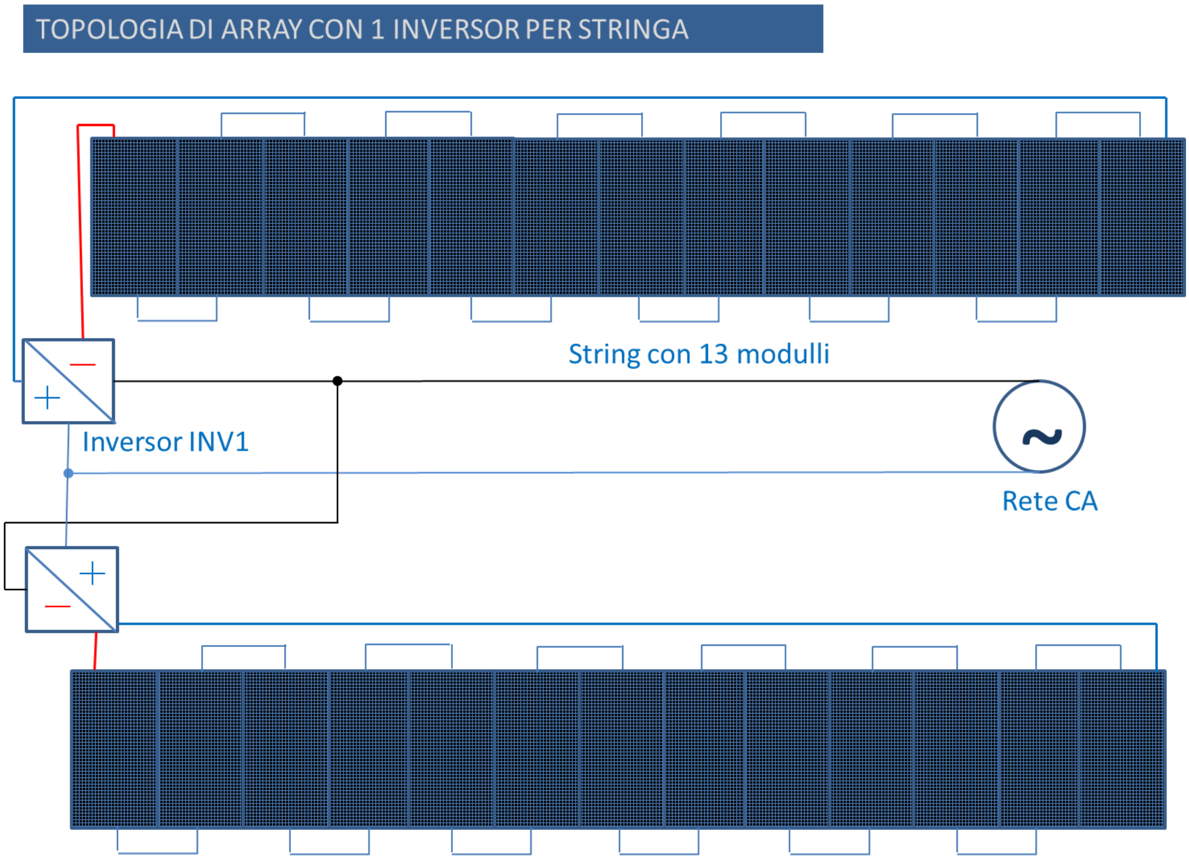


Fig 2. Array with one inverter for each string

Each module has 1053 x 1590 as its basic dimensions. Considering the 41,86 degree inclination to respect the local latitude, the distance between the modules has to be about 3,5 meters to respect the shadowing conditions

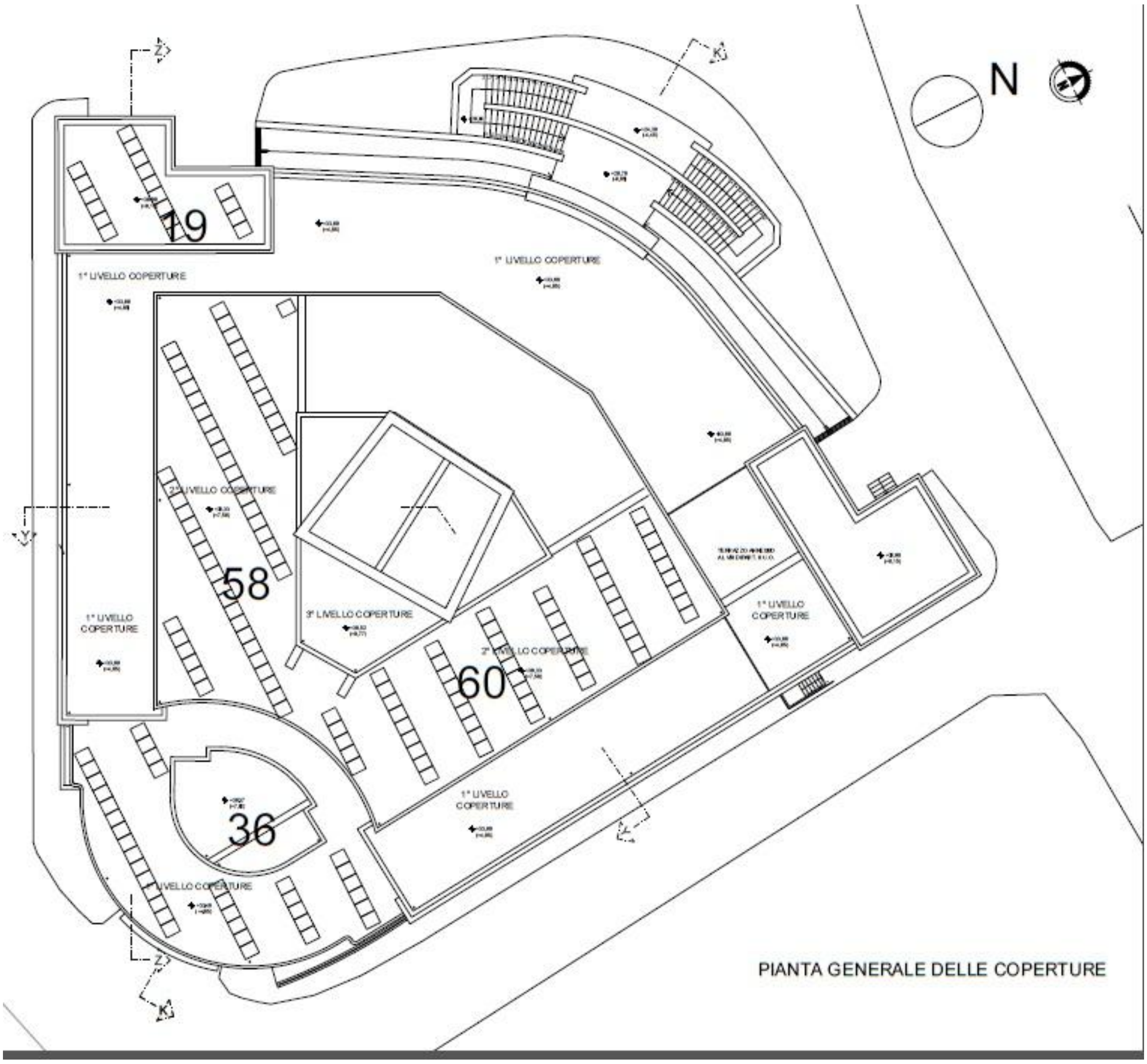


Fig 3. Surface of the building

The total energy supplied by the modules comes to the inverter and goes through the cables to supply the building. The exceeded power will be sent to the utility electrical system through a bidirectional counter that will replace the one installed at the building. The new counter will register how much energy will be supplied from the building to the utility and how much energy will be supplied by the utility to the building.

DIAGRAMMA PICTOGRAFICO DEL SISTEMA PV

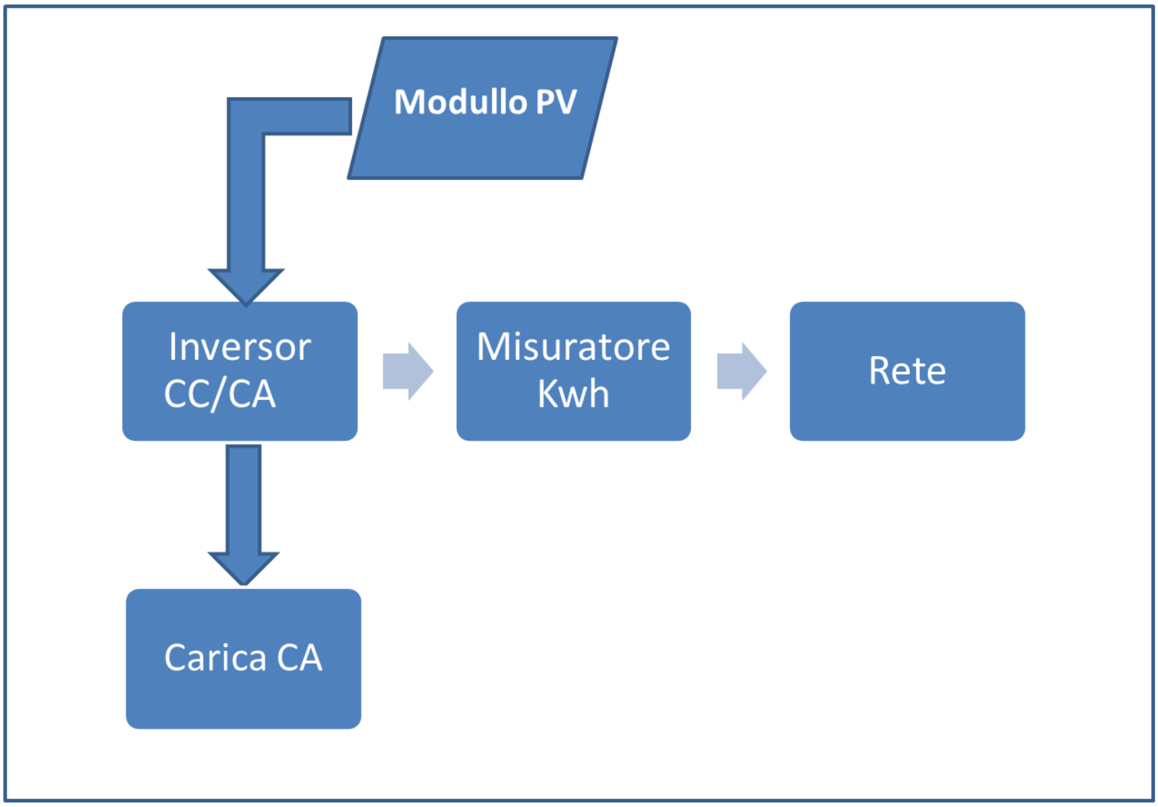


Fig . Pictographic Diagram of the system.

The billing payment of the energy supplied from the building to the utility is in charge of the GSE as defines the local regulation.

INSTALLATION

Before setting the system, it is necessary to check the local regulation and prepare the documentation to provide to the local authorities.

First of all, an Special authorization to ask the permission to install the photovoltaic system has to be done. Also, with this authorization have to be delivered: the final project of the photovoltaic system, the quote from the utility company to install the system to the local electrical system, the project of each step for the installation, the quote to disconnect the system and the technical datasheet of the responsible to install the system. Also, it is necessary to consign to the city hall the "Comunicazione in Edilizia Libera" and the "Procedura Abilitativa Semplificata" to inform the beginning of the activity. The average time response is about 180 days. After that, the electrical supplier has to be communicated if the request been approved.

The installation process of the photovoltaic system consists of clearing the area that will be occupied by the modules. The area has to be prepared with prefabricated metallical structures made of aluminum to permit to attach and incline the photovoltaic modules.

The photovoltaic modules have to be placed at the roof, attached and cabled as following the instructions defined by the device datasheet. The inductive coupling has to be reduced to avoid lightning current. It has to be placed as close as possible of the string roundtrip, avoiding the twist of the cables on the string.

If possible, the cables can be attached to the carrier profile with special cable ties UV resistant. After installed, a prove has to be done to guarantee the correct interconnection of the modules measuring the open circuit voltage of each string. These values have to correspond to the ones at the module datasheet.

The inverters have to be connected to its strings. To cable the other strings to the module series the polarity has to be respected.

The bidirectional counter, responsible to measure the amount of energy supplied and consumed by the building has to be chosen respecting the characteristics of the current energy supplier. Also, to connect the system to the public electrical system, the parallelism conditions from the system to the utility have to be respected. Voltage, frequency and wave shape have to correspond to the same one on the utility.

The voltage level of the system: The inverter has to be set respecting the voltage level of the utility, equal to 220V. The frequency cannot be different from the frequency of the utility, 50 Hz (respecting the tolerance applied).

The electrical insulation: The electrical insulation of the system have to respect the utility electrical insulation as the cable insulation.

The impedance matching of the system has to respect the range. The connection of the system to the utility have to be under Enel responsibility and has to be followed by and engineer or authorized technician.

MANPOWER

Manpower	Salary /hour	Quantity	Work ed hours	Manpower total	Total salary
Electrotecnician	17	1	8	8	€ 136,00
Workman	13	6	36	216	€ 2.808,00

PHOTOVOLTAIC SYSTEM OPERATION

After installed and connected to the energy utility the photovoltaic system operation depends on the climatic conditions to guarantee the energy supply.

For a sunny day with no clouds and an average cell temperature of 25 Celsius degrees, the system is able to work on the nominal conditions. However, the photovoltaic modules are sensible to high temperatures. For example, at a hot day, the system has a high yield lose due to the voltage drop from the heater of the photovoltaic cells. On the other hand, when the day is very cold o very cloudy, for example at night, the system does not produce energy. It is considered an open circuit and presents a high voltage level. For these reasons, the system has to be projected considering the high voltage conditions, when the system is opened, and high current conditions, when the system is short circuited from the heater of the cells. To respect these conditions, considering that the chosen inverter can holds a system of up to 1kV, it is possible to connects 13 modules on each string.

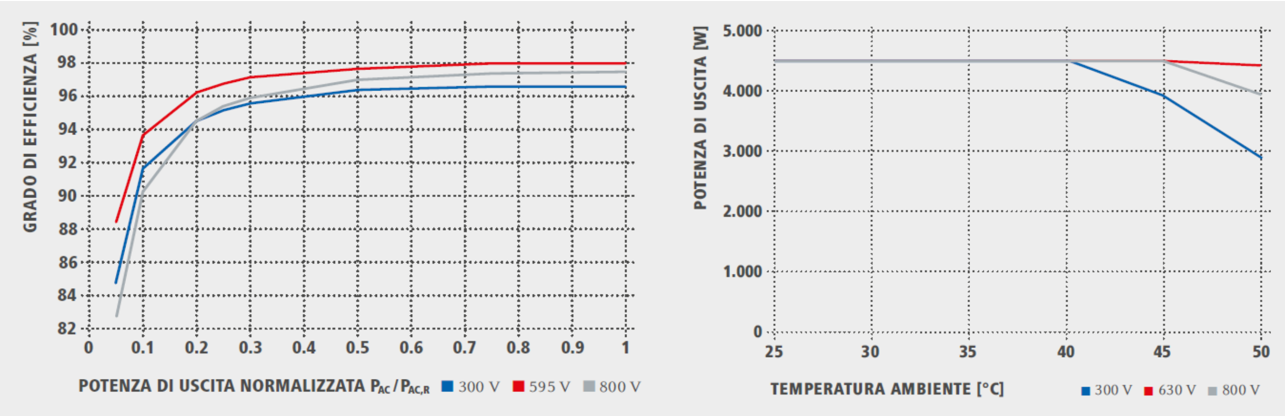


Fig. 4. Fronius Symo 4.5-3-M Degree of efficiency and temperature derating curve

It is indicated to start setting the photovoltaic system installing two strings, sufficient to produce a total peak energy of 8,58 kW, able to supply the basic activities of the Social Center La Strada. The proposed system guarantee the increment of 4290Kw for each installed string. The photovoltaic module proposed has been chosen for being able to offer a high efficiency occupying a reduced area. If the total energy demands of the building reduces, it is possible to change the photovoltaic module for a more economical one.

In particular, in regards to the project's energy sustainability, describe what's is/what's the main energy consumption in the existing building space.

At the moment, the building is supplied from the utility of the region. After the installation of the photovoltaic system, that produces a sustainable energy from a renewable energy source, the building would finally stop depending exclusively from the local energy utility, where about 50% of the produced energy is not renewable.

Energy consumption after the regeneration intervention and through which efficiency measures and renewable energy measures

The total consume of the diverse forms of energy: water, gas and electricity is not going to be changed just with the installation of the photovoltaic system. Is important to understand that the system is not able to reduce the energy consumption of the building. The regeneration project does not preview an energy efficiency system at the building. Instead, proposes the sustainable energy generation the reduction of the non-sustainable energy dependency. Therefore, the photovoltaic system proposed is composed of smart devices, as the inverter model, able to be connected to an energy efficiency management system.

REDUCING OVERALL CO2 EMISSION

As is going to be shown at the unity 4 of this project, for a 50 kWp system, the overall C02 emission reduction is of 37,3 ton a year. This value times the lifespan of each photovoltaic panel (about 25 years) results in a total CO2 reduction of 932,5 tons.

What other related measures do you plan to reduce the overall CO2 emission and other environmental impacts of the future regenerated space?

The installation of a photovoltaic system on the buildings' roof does not represent an imminent environmental impact because it is going to be installed in an area with no vegetation. The decision to take the chosen equipment for the project took in consideration the timespan of each device, to have more durability of the materials and less soil.

The photovoltaic system will occupy less than 50% of the total available area to guarantee the energy production for the CSOA La Strada, Farmers Market and Coworking center. Thanks to the high efficiency of the chosen photovoltaic module is possible to have a reduction of the total number of modules needed and, consequently, to the reduction of the area occupied. Also, as the lifespan of the modules are long 25 years and it can preserver its efficiency in 80%, the system offers a better productivity with less disposal.

Even if at a first glance the proposed solutions could seem only about the environment, allowing a sensible reduction of CO2 released in the atmosphere; the social aspects, expressed through the collaboration of the various actors present in the territory and the awareness of the public opinion about the environmental themes, and the economic aspect, generated from the municipality savings, that would be savings for the whole community, are part and parcel of the regeneration project and result clear if the context is analysed in a deeper way. As already discussed previously, the project is composed of two different solutions that contribute to the same common objective, so it will be useful to analyse in which way the solar panels and the bicycle-generators solutions would be collocated in the sustainability context, in particular the way its three main pillars (environmental, social and economic) are dealt with. For what concerns the environmental aspect, even though both the proposed solutions would contribute to a reduction of the electrical consumption derived from non-renewable sources, and to a minor amount of CO2 emissions, the solar panels surely have a much greater impact on this particular aspect. In particular, given the emission factor for the thermoelectric Italian national production, to an equal extent of 505,4 gCO2/kWh, and trough the kWh/year produced for a kWp installed in Rome, equal to 1477,4 kWh/year, it was possible to calculate the CO2 amount that would not go in the atmosphere if the solar panels would be installed: that is equal to 746,7 Kg CO2/year per kWp installed; if we suppose to install a 50kWp plant, the CO2 savings would be of 37,3 ton CO2/year that multiplied for the average lifetime of the particular solar panels used (25 years) would involve a total saving of 932,5 ton CO2.

For what concerns the sustainability from an economic point of view, first of all it would be necessary to describe the actual context; in fact the actors situated in the structure currently pay a small fee to the municipality for the electric consumption, so the main part of the costs are currently bore by the public. The realization of the solar plant would implicate, against a starting investment, savings during time that would benefit the whole community. Additional details regarding the costs and return of investment will be provided in the business plan. Last but not least, for what concerns the social aspect of the project, the fulfilment of the bicycle-generators, in collaboration with the bicycle workshop already situated in the social centre "La Strada" would be fundamental. The bicycle-generators will underlie some events organised with the purpose of raising money and sensitize the public opinion, showing with concretes examples how electric production it's not necessarily associated to non-renewable resources. In this project's phase the involvement of all the main actors (the social centre "La Strada", the farmer's market and the coworking "Millepiani") would be fundamental, only in this way the major number of people could be reached and different levels of knowledge could be used for the development of the project.

Risks

Environmental impact

The use of solar panels as power source has as the main advantage of the sharp decline of CO2 emitted in the air compared to the use of energy from fossil fuels. Nevertheless, it should not be underestimated the impact that can have the choice of the photovoltaic panel.

An overall assessment of the sustainability of individual technologies must be carried out taking into account a number of criteria. These criteria include short- and long-term cost considerations, energy security, the impact on land use, social acceptability, environmental impacts and resource requirements.

According to a study by the Wuppertal Institute for Climate, Environment and Energy geological availability of minerals in general is not a limiting factor for the planned expansion of renewable energies if they are chosen technologies that relate to minerals "non-critical" as the silicon, used in our case, instead of the thin-film cells consist of rare earths.

As regards the storage of electricity, it is recommended the use of lithium ions, which are considered less critical from the point of view of the availability of resources, or materials storage facilities (power stations having pumping basin, air tanks tablet) for short-term storage.

Finally, it essential to focus on medium-term strategies to improve efficiency and recycling with the aim of ensuring the supply of raw materials for the future. However, each recycling process involves, in some cases, a considerable loss of material and a high energy consumption. In the case of silicon panels, nowadays the percentage of recycling up to 95%.

In conclusion, the environmental impact of photovoltaic silicon is not null, but clearly inferior to other technologies and especially to fossil fuels.

Degradation from progressive aging

The technical literature highlights that the types of photovoltaic cells in production today are subject to a progressive degradation. The extent of degradation differs between the different types of materials for both trends over time that in quantitative terms. The cells in monocrystalline silicon, and similarly those in polycrystalline silicon, are characterized by an initial efficiency degradation, during the first year of life, at around 2%, stabilizing then on a level estimated today between 0.3% and 0.9% per year. The amorphous silicon shows a more constant degradation estimated at between 0.7% and 0.9% per year.

Worth noting the results obtained from the experimental centre of the Italian National Institute for Environmental Protection and Research (ISPRA) which reveals, after 22 years of operation, a nearby residual efficiency to 90%, followed by an annual degradation amounting to about 0.5%. The type of inverter can affect the performance degradation. Several studies have shown that the use of inverters without transformer, so do not galvanically isolated, creates a reduction in electrical conductivity due to the increase of the flow of sodium ions (often contained in the vitreous parts), in particular based on panels thin film technology.

Electrical contacts

A very important issue, which affects significantly the efficiency over time of photovoltaic panels, is cables with their connectors and the boxes containing the electrical contacts. Usually the electric circuit constituted by photovoltaic cells, inserted in the sandwich panel, is connected with the outside of the implant by means of special boxes placed in the bottom of the panel, and then in a reasonably protected zone from drippings and moisture. It is however to be considered as an important risk factor - both for the efficiency of the plant and for the safety of persons - the incorrect or lasting sealing of the panel cut-out through which the internal electric circuit is put in connection with the outside. Similarly they are to be considered potentially critical connectors of the connection cables between the different panels of a string, which are subject to thermal stresses, mechanical and chemical. For all the equipment shall have at least an IP54 protection level and specifically for connectors, the following rules must be followed: - the existence of a physical block to be deactivated before disconnecting; - high mechanical strength, which is valid even after repeated manoeuvres of connection and disconnection; - high electrical insulating capacity (substantially imposes double insulation); - non-reachability of the part in tension, even in case of open connector; - high resistance to stresses deriving from the environment, in particular · for UV rays; · for the temperatures (-55 ° C / + 150 ° C); · to moisture and / or rain.

Given the large dimension of the solar power plant project it was necessary to do an evaluation of the total costs of the plant, and of how its initial cost could be amortised during the solar panels lifetime.

For what concerns the initial cost, it was estimated in 110.000 €, in the following table it’s shown how the total cost is divided.

Investment costs for a 50 kWp plant	
	(€)
Solar panels	65.000
Inverter	11.000
Support structures	12.000
Wires	7.000
Installation costs	15.000
Total cost	**110.000**

It’s clear how the main part of the costs it’s made up by the solar panels (around 60% of the total).

To compile the business plan we supposed to receive a loan to be repaid in 15 years with a 3% interest rate, that would imply a fixed payment of 760 €/month.

Given the uncertainty for the future use of the area, in particular for the farmer's market, we decided to consider three different scenarios with different percentages of self-consumption of the electric energy produced in the solar plant. In the following charts for each scenario are reported the costs and revenues for the first twenty year.

In particular we supposed an energy production loss of 1% every year, a cost for the energy bought from the electric company of 0,25 €/kWh, a selling cost for the energy produced of 0,11€/kWh and some cost for the ordinary maintenance and insurance for 2000€/year.

70% self-consumption scenario						
Year	Produced energy	Saving on the electric bill	Income from sold energy	Costs	Annual loan payment	Cash flow
	(kWh)	(€)	(€)	(€)	(€)	(€)
1	65000	11375	2145	2000	9120	2400
2	64350	11261,25	2123,55	2000	9120	4664,8
3	63700	11147,5	2102,1	2000	9120	6794,4
4	63050	11033,75	2080,65	2000	9120	8788,8
5	62400	10920	2059,2	2000	9120	10648
6	61750	10806,25	2037,75	2000	9120	12372
7	61100	10692,5	2016,3	2000	9120	13960,8
8	60450	10578,75	1994,85	2000	9120	15414,4
9	59800	10465	1973,4	2000	9120	16732,8
10	59150	10351,25	1951,95	2000	9120	17916
11	58500	10237,5	1930,5	2000	9120	18964
12	57850	10123,75	1909,05	2000	9120	19876,8
13	57200	10010	1887,6	2000	9120	20654,4
14	56550	9896,25	1866,15	2000	9120	21296,8
15	55900	9782,5	1844,7	2000	9120	21804
16	55250	9668,75	1823,25	2000	0	31296

17	54600	9555	1801,8	2000	0	40652,8
18	53950	9441,25	1780,35	2000	0	49874,4
19	53300	9327,5	1758,9	2000	0	58960,8
20	52650	9213,75	1737,45	2000	0	67912

Reading the chart seems obvious how a 70% self-consumption would allow the plant to be economically sustainable and to earn around 68.000€ after 20 years.

50% self-consumption scenario						
Year	Produced energy	Saving on the electric bill	Income from sold energy	Costs	Annual loan payment	Cash flow
	(kWh)	(€)	(€)	(€)	(€)	(€)
1	65000	8125	3575	2000	9120	580
2	64350	8043,75	3539,25	2000	9120	1043
3	63700	7962,5	3503,5	2000	9120	1389
4	63050	7881,25	3467,75	2000	9120	1618
5	62400	7800	3432	2000	9120	1730
6	61750	7718,75	3396,25	2000	9120	1725
7	61100	7637,5	3360,5	2000	9120	1603
8	60450	7556,25	3324,75	2000	9120	1364
9	59800	7475	3289	2000	9120	1008
10	59150	7393,75	3253,25	2000	9120	535
11	58500	7312,5	3217,5	2000	9120	-55
12	57850	7231,25	3181,75	2000	9120	-762
13	57200	7150	3146	2000	9120	-1586
14	56550	7068,75	3110,25	2000	9120	-2527
15	55900	6987,5	3074,5	2000	9120	-3585
16	55250	6906,25	3038,75	2000	0	4360

17	54600	6825	3003	2000	0	12188
18	53950	6743,75	2967,25	2000	0	19899
19	53300	6662,5	2931,5	2000	0	27493
20	52650	6581,25	2895,75	2000	0	34970

Reducing the self-consumption percentage at 50%, the total income gets lower because of the price difference between the energy sold or bought from the electric company; in particular we would have a negative balance between the year 11 and year 15, but the debt would be repaid in the last five year in which there wouldn't be the annual loan payment. On the year 20 there would be a positive balance of around 35.000 €.

50% self-consumption scenario						
Year	Produced energy	Saving on the electric bill	Income from sold energy	Costs	Annual loan payment	Cash flow
	(kWh)	(€)	(€)	(€)	(€)	(€)
1	65000	4875	5005	2000	9120	-1240
2	64350	4826,25	4954,95	2000	9120	-2578,8
3	63700	4777,5	4904,9	2000	9120	-4016,4
4	63050	4728,75	4854,85	2000	9120	-5552,8
5	62400	4680	4804,8	2000	9120	-7188
6	61750	4631,25	4754,75	2000	9120	-8922
7	61100	4582,5	4704,7	2000	9120	-10754,8
8	60450	4533,75	4654,65	2000	9120	-12686,4
9	59800	4485	4604,6	2000	9120	-14716,8
10	59150	4436,25	4554,55	2000	9120	-16846
11	58500	4387,5	4504,5	2000	9120	-19074
12	57850	4338,75	4454,45	2000	9120	-21400,8
13	57200	4290	4404,4	2000	9120	-23826,4
14	56550	4241,25	4354,35	2000	9120	-26350,8
15	55900	4192,5	4304,3	2000	9120	-28974

16	55250	4143,75	4254,25	2000	0	-22576
17	54600	4095	4204,2	2000	0	-16276,8
18	53950	4046,25	4154,15	2000	0	-10076,4
19	53300	3997,5	4104,1	2000	0	-3974,8
20	52650	3948,75	4054,05	2000	0	2028

In the last scenario's hypothesis the income gets even lower keeping a negative balance until the year 20, that ends with a positive balance of just 2000 €. So it's clear how the risk investment gets higher with a lower self-consumption percentage.

The bicycle-generators are bicycle connected on the rear wheel to a power unit. The kinetic energy produced by the pedal is transmitted to the generator and, like in a dynamo, the bicycle-generators produce clean electrical energy through mechanical energy.
The power unit generate an electrical current of 12 volt that changes in intensity and potential difference depending on the on the pedalling speed. Because of these variations the power unit cannot be used as it is, if not just for simple uses like lighting a light bulb. For other uses the power unit loads a battery, that through an inverter, it's capable of powering the 220 volt devices.
The bicycle-generators are both communication and entertainment tools: their purpose is to make tangible in a funny way, the effort that is needed to produce what for the majority of people is an abstract concept: energy. Every day we make simple actions, like pressing a switch or turning on an electrical appliance, and we often don't think of what's hiding behind that switch.
This technology has many different applications, like making some small electrical appliances work or charging phones and PCs.
From a technical point of view the bicycle-generator is composed of a floor support for the bike, on which an alternator is connected, so that the rear wheel could be raised off the floor and connected to the alternator pulley. The alternator is also connected to a battery, needed to activate the alternator. The battery is connected to a 12V -> 220V inverter.

The following list contains the materials needed, their costs and the estimated time needed for the construction.
Alternator: 20 €, can be bought from a car dismantler;
bicycle: the ideal would be to use one already present in the bicycle workshop;
battery: a new one costs around 30-40 €;
inverter 12V -> 220V: a new one would cost around 100 €, it could be possible to obtain it from an old computer UPS;
bicycle support: could be built in the bicycle workshop using metal scrap.
We estimated in 10 hours the needed time to build the support and assemble all the needed components. So having already a bicycle available the total cost would be of 150 €.