



გენერა



02

genera

genera  
integrated system



Modern construction trends seek to integrate buildings with their surroundings. These days, with reworkings of splendid examples from the past, buildings are no longer considered as separate entities, but as structures that interact with their surroundings. A building cannot be thought of as a shell to which energy, electrical, water, and heating plants are then added. It has to be designed from its beginning as an integral part of its surroundings.

To achieve this goal, GENERA was founded as a single company boasting all the specific skills required to integrate the design and creation of applied technologies with eco-sustainable architecture.

Genera's integrated system represents the functional synergy of all the technologies involved in its realisation, together with all the economic and environmental benefits that it produces. The photovoltaic plant, roof garden and pond unite to form a single, flexible system that can be adapted to an existing building or to one under construction.

genera  
integrated system

03

genera

Integration of a photovoltaic system with a roof garden and a pond, built and tested by GENERA, optimises and considerably reduces a building's electrical and water consumption and improves its environmental impact.

**GENERA** was founded with the idea of creating an efficient system that exploits new synergies from elements deriving from cutting-edge research in eco-sustainable architecture: photovoltaic plants, roof gardens, and ponds.

**GENERA** also offers great flexibility when integrated into existing buildings. Clean energy and water saving are necessary, even vital, to ensure real efficiency improvements in state-of-the-art buildings.

**GENERA** offers innovative design and building methods to architectural firms and construction companies in the hotel, residential, and industrial sectors.

**GENERA** also works in the field of research and development, promoting those environmental technologies most capable of aiding mankind's integration with nature.





06

genera

## integrated system

## photovoltaic

A photovoltaic plant uses clean and renewable solar energy to produce electrical energy by means of the photovoltaic effect.

Determining the size of the photovoltaic plant is the first step in the design stage. It is calculated on the basis of expected annual energy needs and position of the structure. This requires the consideration of two essential aspects: azimuth orientation and inclination to horizontal axis (based on the latitude and longitude of the site).

The fundamental factor for success of the design is the choice of the optimum plant size. This must not exceed real energy needs, thus avoiding unnecessary costs and providing maximum surface area for the roof garden. The collector surface needed by the plant is usually just slightly larger than the area occupied by the photovoltaic modules alone. Thanks to modern technologies, these require approximately  $8 \text{ m}^2/\text{kWp}$ , excepting those surfaces where shadow cones are produced by the modules when not arranged in a coplanar pattern.

Each type of cell has its own consumption in terms of surface area. Based on this parameter, the layout is arranged in multiple rows which are positioned in order to collect as much light as possible. These rows are arranged according to the geometric requirements of the installation site and are based on the electrical configuration of the strings of modules linked in series.

An equipment room must be provided to house the plant conversion and measurement unit, which consists of the inverter, the parallel board, and the meter.

## the benefits of a photovoltaic plant

photovoltaic plant in integrated system

Producing and using energy from a renewable solar source drastically reduces the use of normal fossil fuels, such as coal and oil, and consequently the amount of harmful gases released into the atmosphere.

Every year, each photovoltaic kWp installed saves about 800 kg of CO<sub>2</sub> emissions, about 2kg of nitrogen dioxide emissions and uses 300 kg of oil.

Installation of the photovoltaic plant is completed with the Np Energy cooling system. This increases the plant's energy output by reducing overheating of the panels during spring and summer, when maximum production levels are reached.



construction





08

genera

integrated system

## roof garden

Roof garden is designed and built on a flat or slanted roof fulfilling the criteria set out in the FLL guidelines and by reference standard UNI 11235.

The space occupied by the roof garden depends on the area needed for irradiance and the inclination of the photovoltaic plant. This is calculated in order to achieve the best possible energy production. The creation of the roof garden in the remaining space is carried out according to the guidelines

mentioned above. Roof gardens can be extensive or intensive. The two systems differ in building costs, maintenance requirements and overall performance.

The choice is made by considering building characteristics, the possibility to exploit available work spaces and the best results in terms of functional benefits and environmental impact.

## the benefits of a roof garden

Benefits deriving from the creation of green spaces are fundamental benefits for mankind and for his survival. The most important, and most well-known, process is that of chlorophyll photosynthesis. This is where plants produce oxygen by breaking down  $\text{CO}_2$ .

The roof garden improves environment mitigation through the insertion of structures in the surrounding natural landscape (environmental impact).

A roof garden also provides the following structural benefits:

- **Influence on the climate:** evaporation and transpiration help lower temperature peaks in the surrounding area, providing real advantages on both the micro and macro scale.
- **Trapping and filtering of dust:** plants filter and absorb dust and particulates.
- **Less heat accumulation and reflection by green surfaces,** which means less movement of particles caused by local convection phenomena.
- **Influence on the duration of waterproofing layers:** during the summer, the temperature on a roof garden rarely exceeds  $25^\circ\text{C}$ , as opposed to over  $80^\circ\text{C}$  on a traditional roof. Under these conditions, a waterproofing sheath lasts much longer and does not need to be replaced every 7-10 years.

roof garden





10

genera

integrated system



A pond is a pool of water that forms a balanced ecosystem in residential or public spaces using natural methods and products and, where necessary, energy-efficient technological components.

There are countless uses, types, and forms of ponds. Sometimes purification areas are designed to be clearly separated from the decorative pond; other times a path of phyto-depuration is created together with an open decorative area.

Water is enjoyed in all its wonder and acts as an essential resource thanks to the numerous ways it can be exploited. Water is, in our integrated system, the engine of a vital cycle.

pond

## the benefits of a pond

The pond system is designed according to the building's water needs and optimises available space.

Water is managed and recycled for the following important functions:

- water supply to the roof garden by means of a specific irrigation zone.
- water supply to the drainage and accumulation layer by means of sub-irrigation.
- water supply to the humidifying layer and surface watering system that wet the solar panels (cooling system).

In addition to significant aesthetic enhancement and to the aforementioned characteristics, the pond provides the following functional benefits:

- **roof cooling increase** thanks to the water supply to the drainage and accumulation layer of the roof garden, with consequent beneficial effects (transpiration/ evapotranspiration).
- **accumulation of rainwater** for subsequent recycling.

- **better water quality:** the pond system has a filter zone that usually occupies a third of the total water surface area. The filter zone is filled with NpLVD filter material (the same as that used in the hydrofilter drainage/accumulation layer of the plant system and inside the humidifying layer, in different granulometry, of the cooling system). This filter material has excellent chemical and physical properties, filtering capacity as well as the ability to retain nutrients and trap pollutants. The pond water is firstly pumped into the filter zone for the first purification treatment. Here, phytodepurative plants help absorb pollutants and keep the filter zone oxygenated. After the first filtration, water is pumped up to the roof garden, where it is filtered again, passing through the drainage and humidifying layer. The purified water then flows through drainage pipes and returns to the pond.

the pond



12

genera





13

genera

# genera

is a flexible system

GENERA incorporates a great deal of flexibility in its application thanks to its dynamism. In order to carry out the necessary work, this integrated system can be modelled on existing structures according to a building's energy and water needs, its structural characteristics, as well as the spaces available.

In new projects, GENERA achieves the best results in terms of energy and water saving as well as environmental impact.

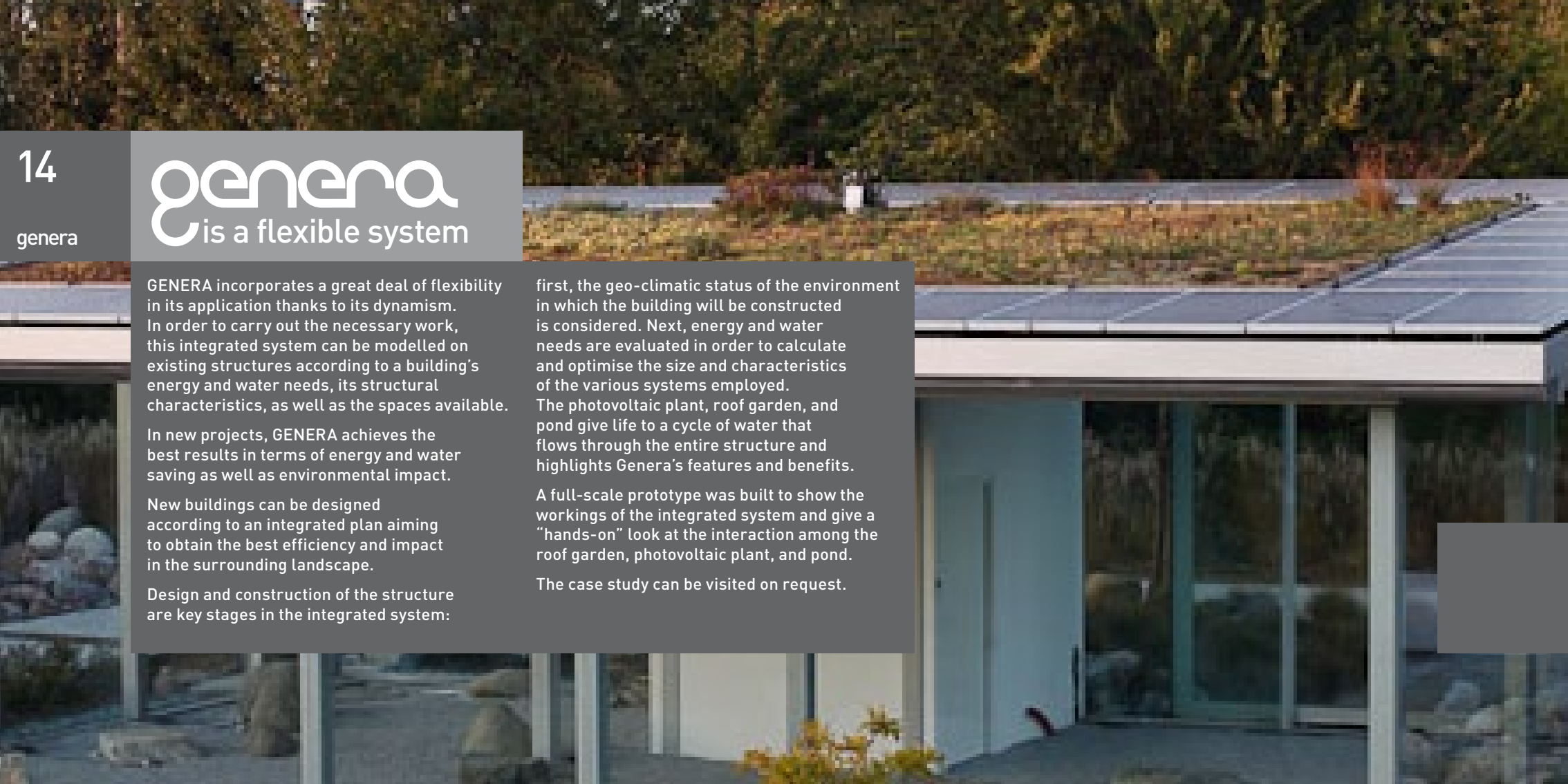
New buildings can be designed according to an integrated plan aiming to obtain the best efficiency and impact in the surrounding landscape.

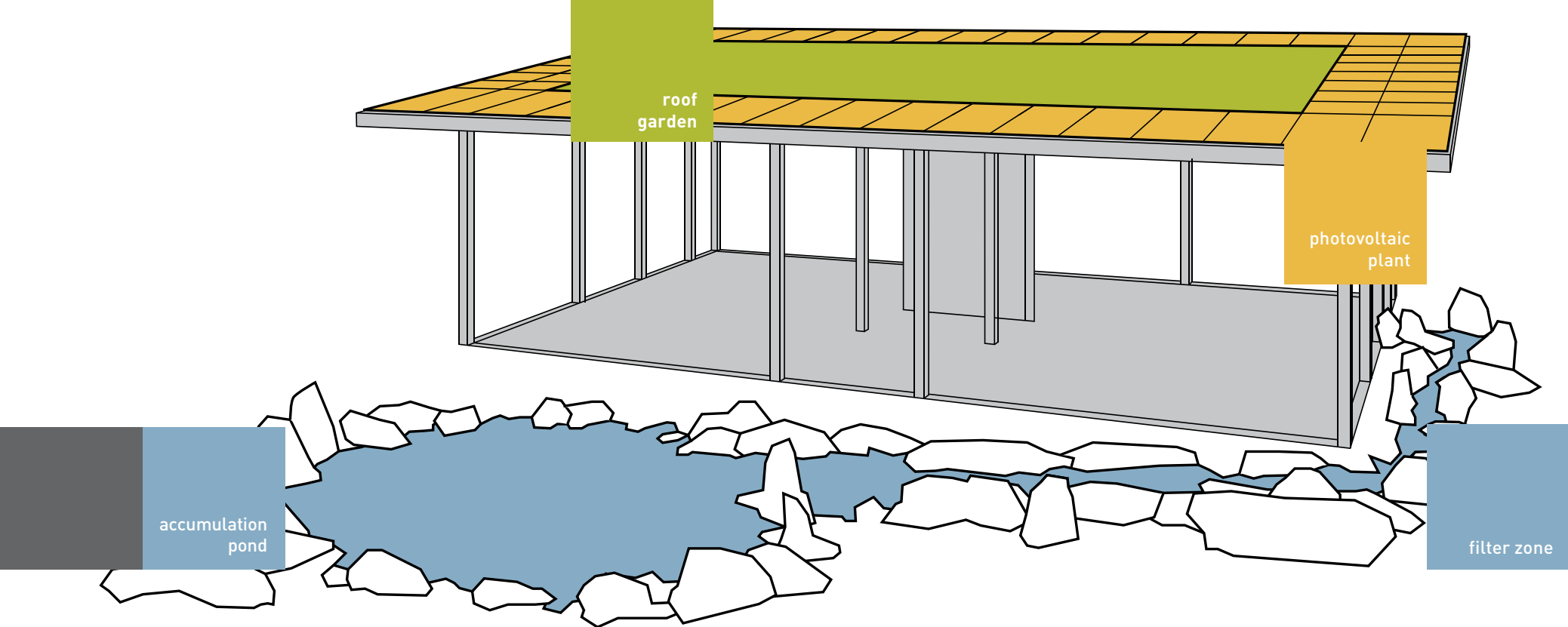
Design and construction of the structure are key stages in the integrated system:

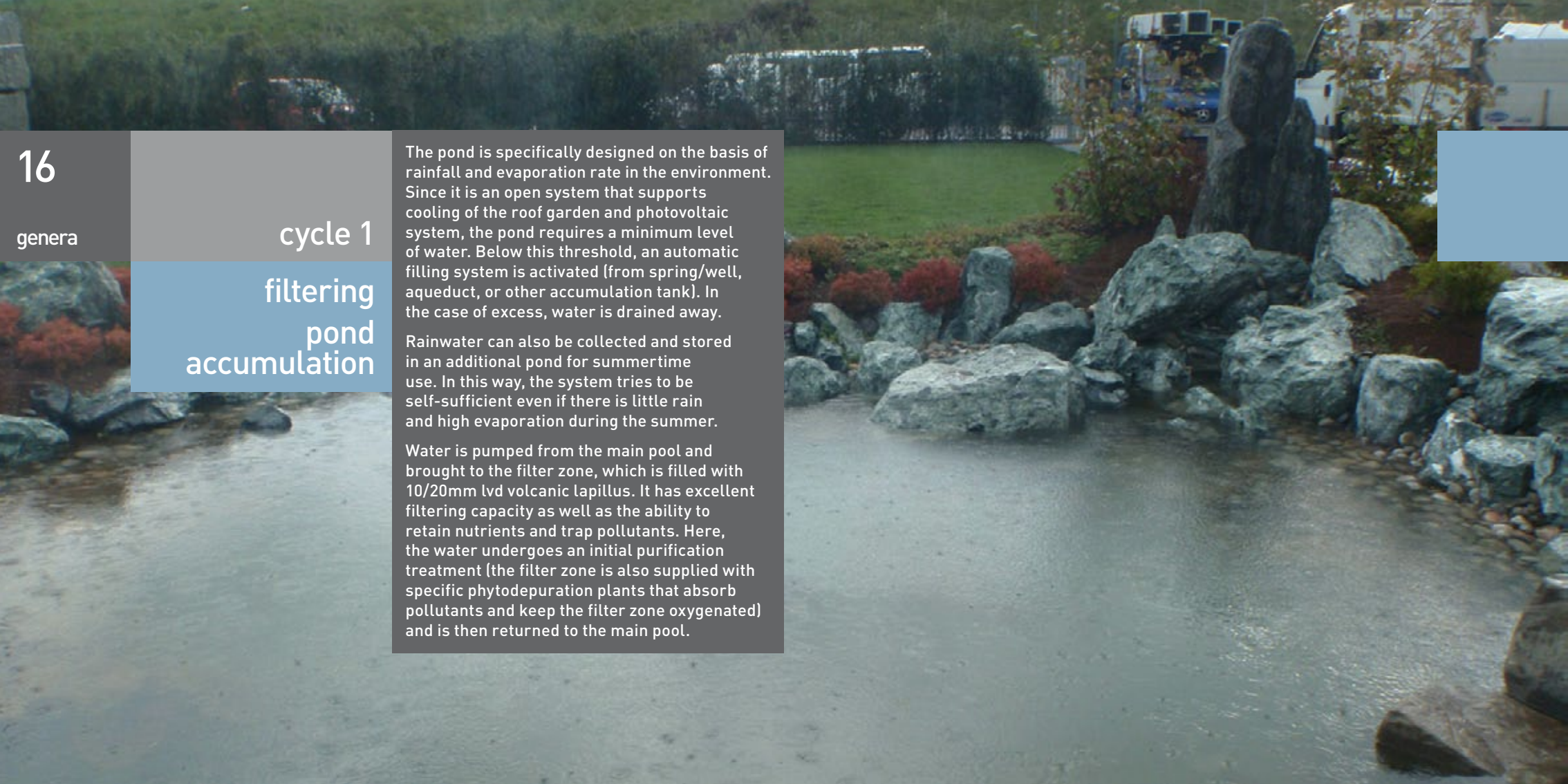
first, the geo-climatic status of the environment in which the building will be constructed is considered. Next, energy and water needs are evaluated in order to calculate and optimise the size and characteristics of the various systems employed. The photovoltaic plant, roof garden, and pond give life to a cycle of water that flows through the entire structure and highlights Genera's features and benefits.

A full-scale prototype was built to show the workings of the integrated system and give a "hands-on" look at the interaction among the roof garden, photovoltaic plant, and pond.

The case study can be visited on request.







16

genera

cycle 1

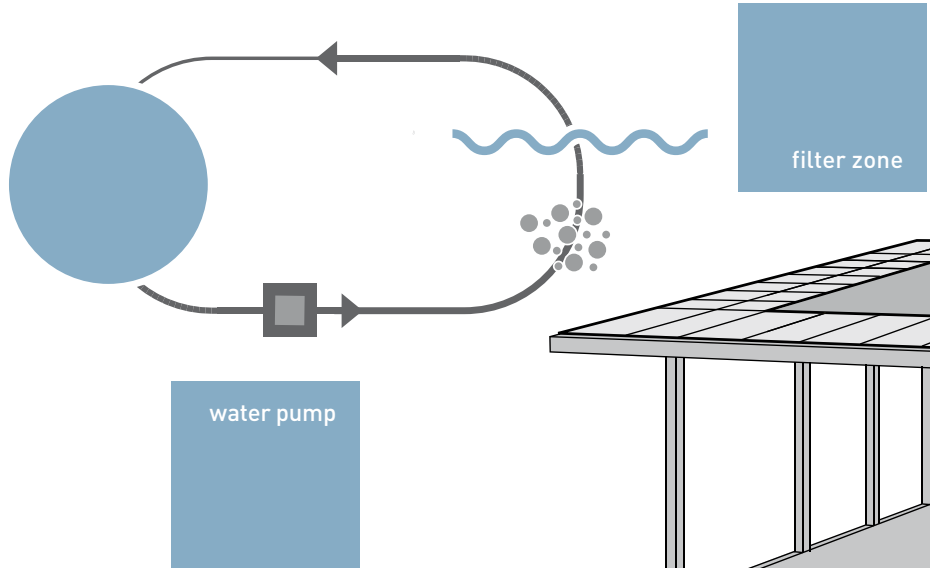
filtering  
pond  
accumulation

The pond is specifically designed on the basis of rainfall and evaporation rate in the environment. Since it is an open system that supports cooling of the roof garden and photovoltaic system, the pond requires a minimum level of water. Below this threshold, an automatic filling system is activated (from spring/well, aqueduct, or other accumulation tank). In the case of excess, water is drained away.

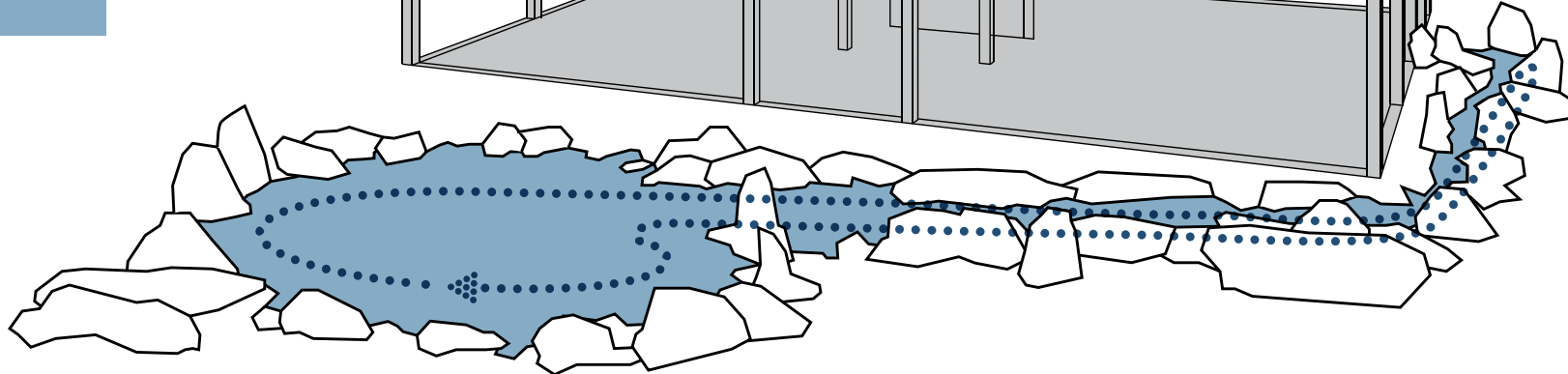
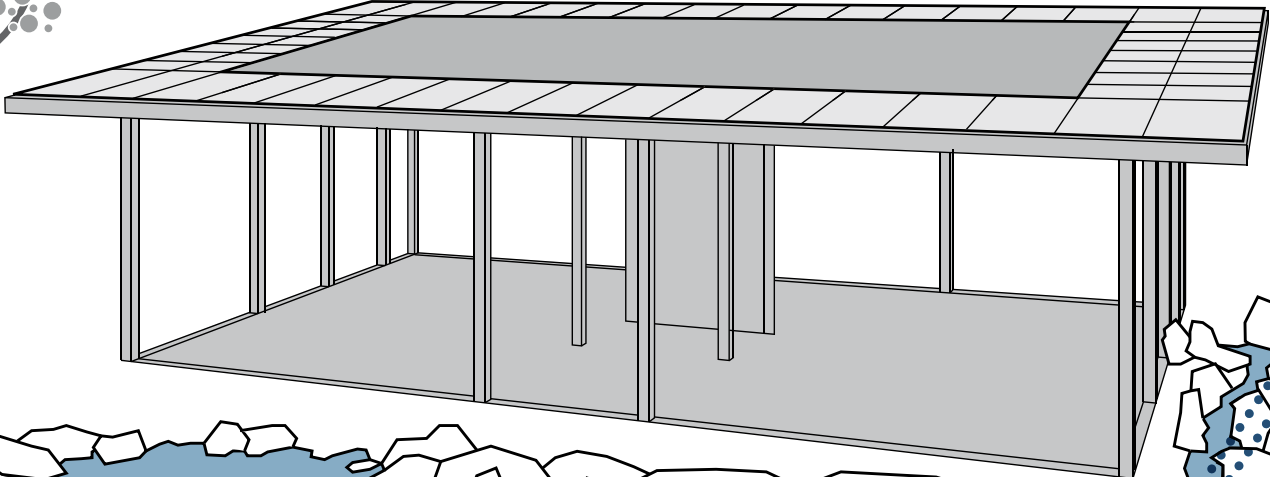
Rainwater can also be collected and stored in an additional pond for summertime use. In this way, the system tries to be self-sufficient even if there is little rain and high evaporation during the summer.

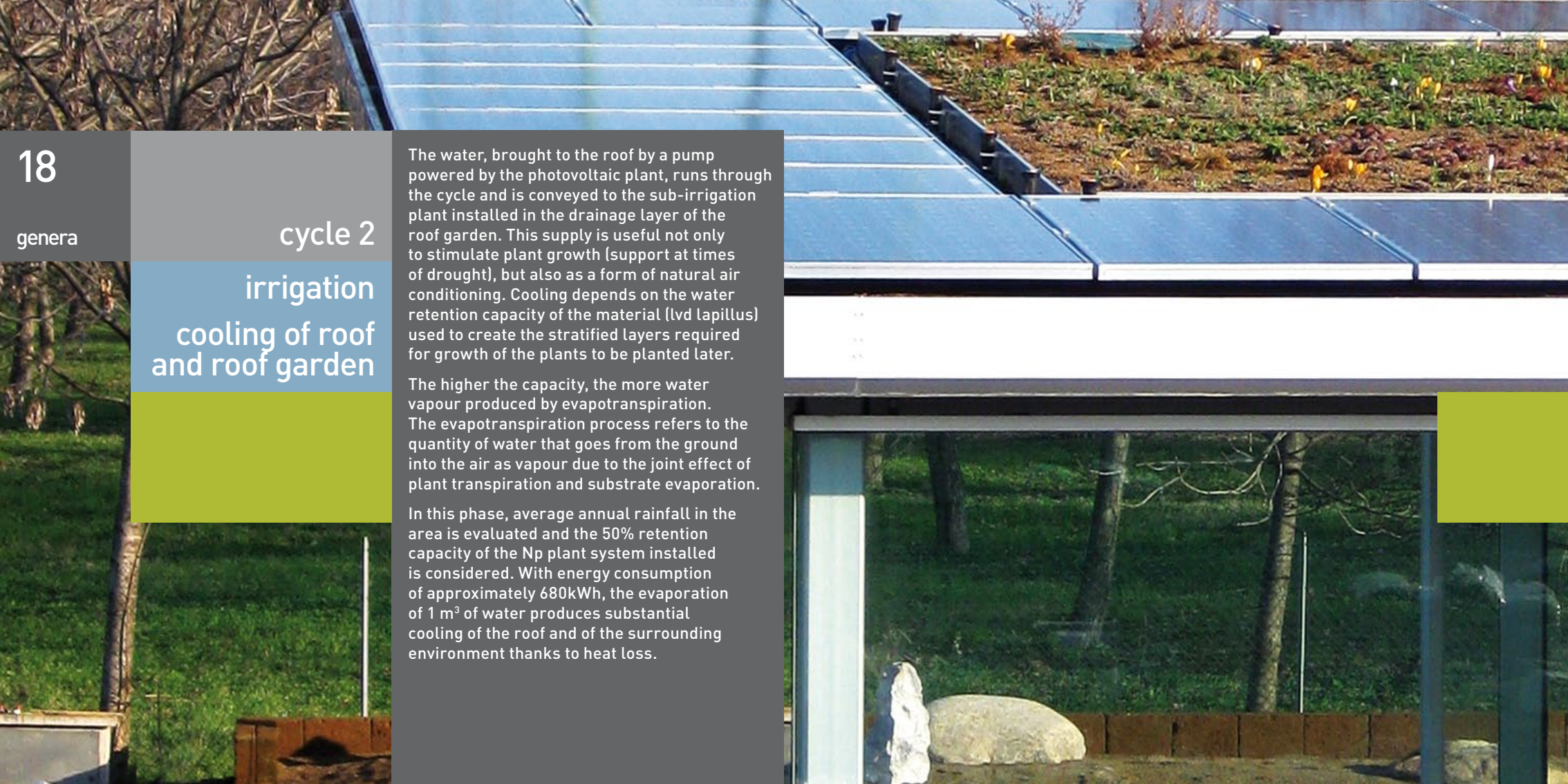
Water is pumped from the main pool and brought to the filter zone, which is filled with 10/20mm lvd volcanic lapillus. It has excellent filtering capacity as well as the ability to retain nutrients and trap pollutants. Here, the water undergoes an initial purification treatment (the filter zone is also supplied with specific phytodepuration plants that absorb pollutants and keep the filter zone oxygenated) and is then returned to the main pool.

accumulation  
pond



water pump





18

genera

cycle 2

irrigation  
cooling of roof  
and roof garden

The water, brought to the roof by a pump powered by the photovoltaic plant, runs through the cycle and is conveyed to the sub-irrigation plant installed in the drainage layer of the roof garden. This supply is useful not only to stimulate plant growth (support at times of drought), but also as a form of natural air conditioning. Cooling depends on the water retention capacity of the material (lvd lapillus) used to create the stratified layers required for growth of the plants to be planted later.

The higher the capacity, the more water vapour produced by evapotranspiration. The evapotranspiration process refers to the quantity of water that goes from the ground into the air as vapour due to the joint effect of plant transpiration and substrate evaporation.

In this phase, average annual rainfall in the area is evaluated and the 50% retention capacity of the Np plant system installed is considered. With energy consumption of approximately 680kWh, the evaporation of 1 m<sup>3</sup> of water produces substantial cooling of the roof and of the surrounding environment thanks to heat loss.



20

genera

cycle 3

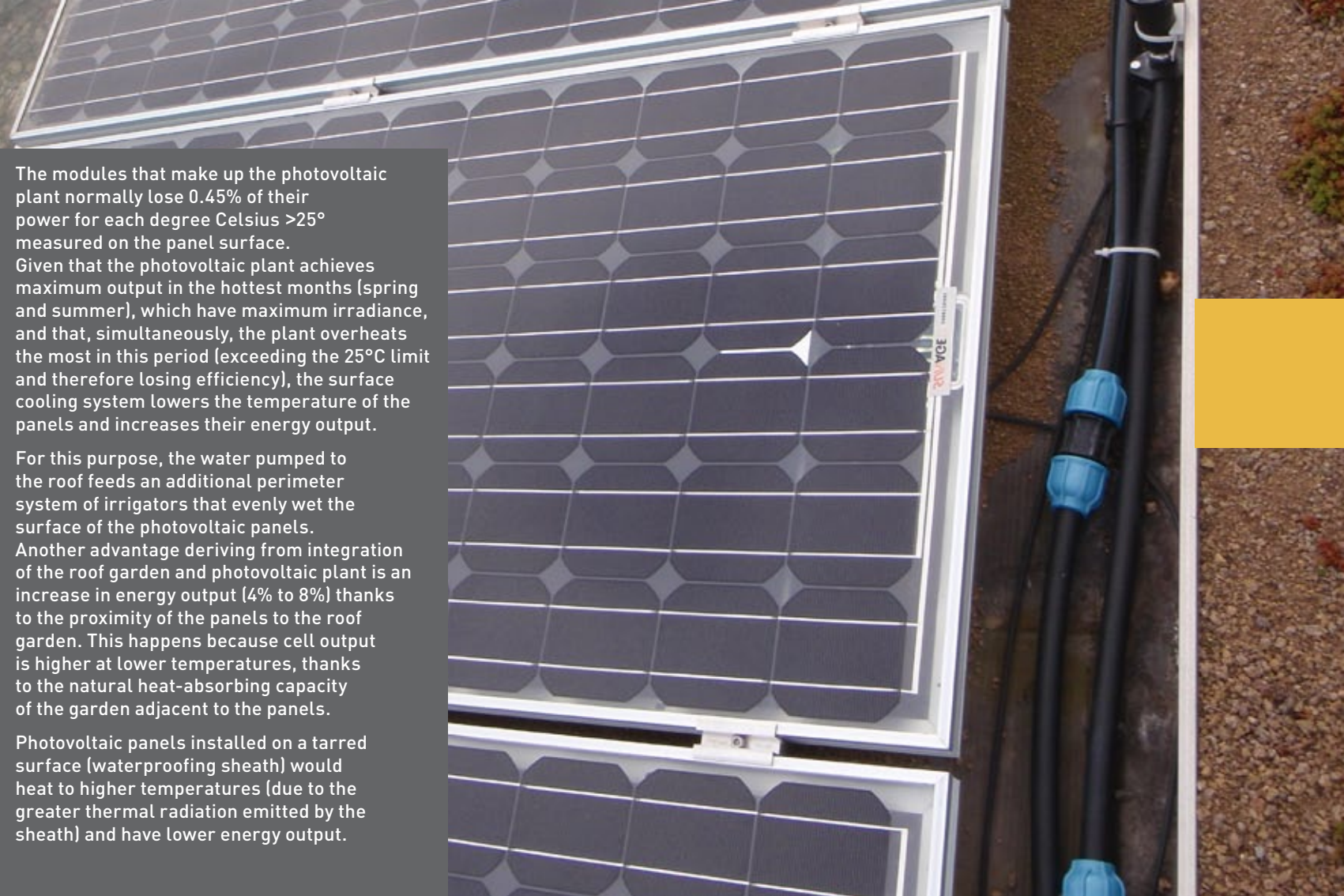
## surface cooling photovoltaic plant

The modules that make up the photovoltaic plant normally lose 0.45% of their power for each degree Celsius  $>25^{\circ}$  measured on the panel surface.

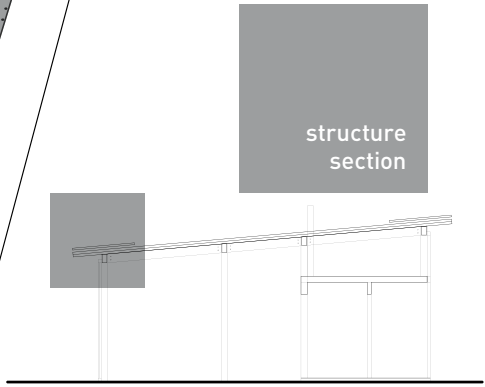
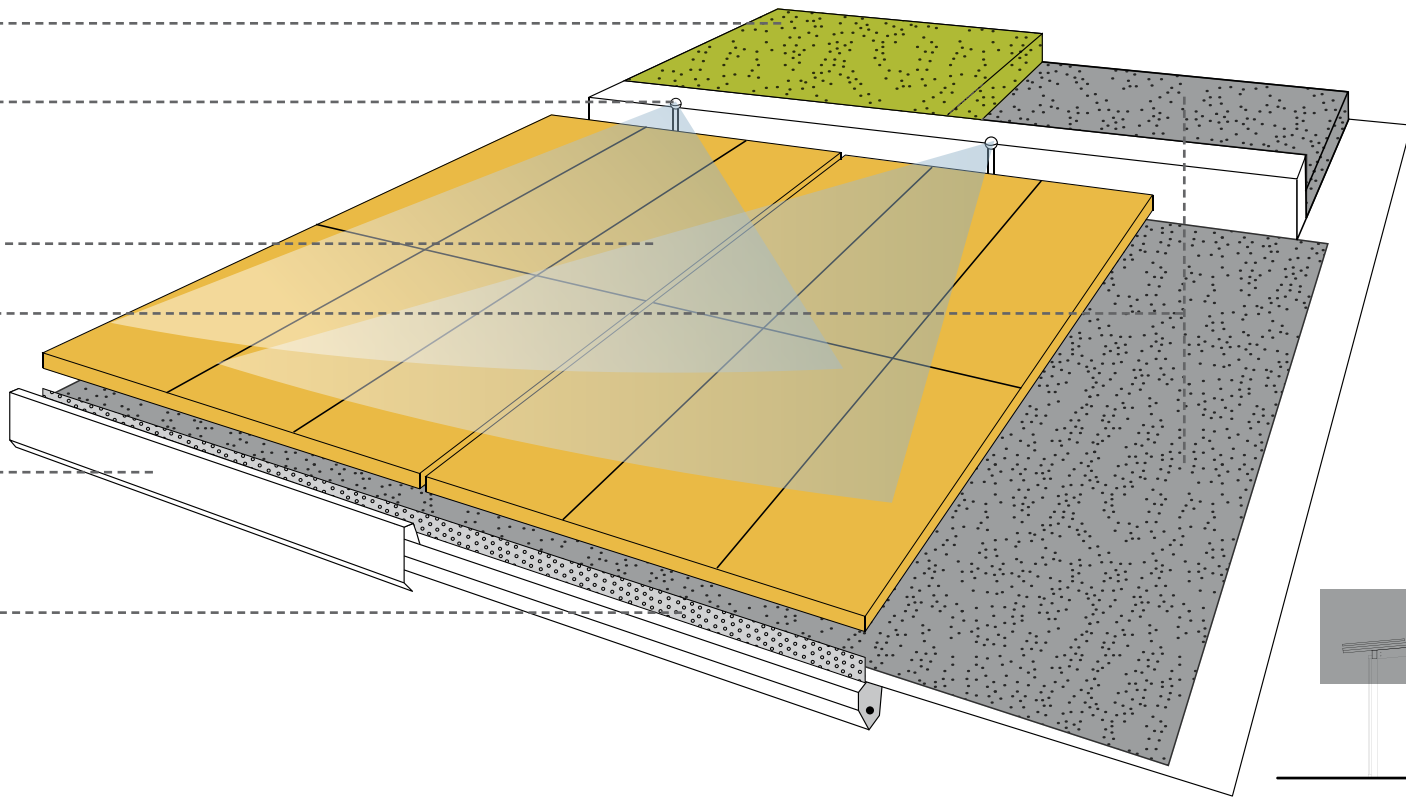
Given that the photovoltaic plant achieves maximum output in the hottest months (spring and summer), which have maximum irradiance, and that, simultaneously, the plant overheats the most in this period (exceeding the  $25^{\circ}\text{C}$  limit and therefore losing efficiency), the surface cooling system lowers the temperature of the panels and increases their energy output.

For this purpose, the water pumped to the roof feeds an additional perimeter system of irrigators that evenly wet the surface of the photovoltaic panels. Another advantage deriving from integration of the roof garden and photovoltaic plant is an increase in energy output (4% to 8%) thanks to the proximity of the panels to the roof garden. This happens because cell output is higher at lower temperatures, thanks to the natural heat-absorbing capacity of the garden adjacent to the panels.

Photovoltaic panels installed on a tarred surface (waterproofing sheath) would heat to higher temperatures (due to the greater thermal radiation emitted by the sheath) and have lower energy output.



- vegetation on Np substrate
- static irrigator
- photovoltaic panel
- lapillus lvd
- insulated structural fretted seam panel
- drainage profile





22

genera

cycle 4

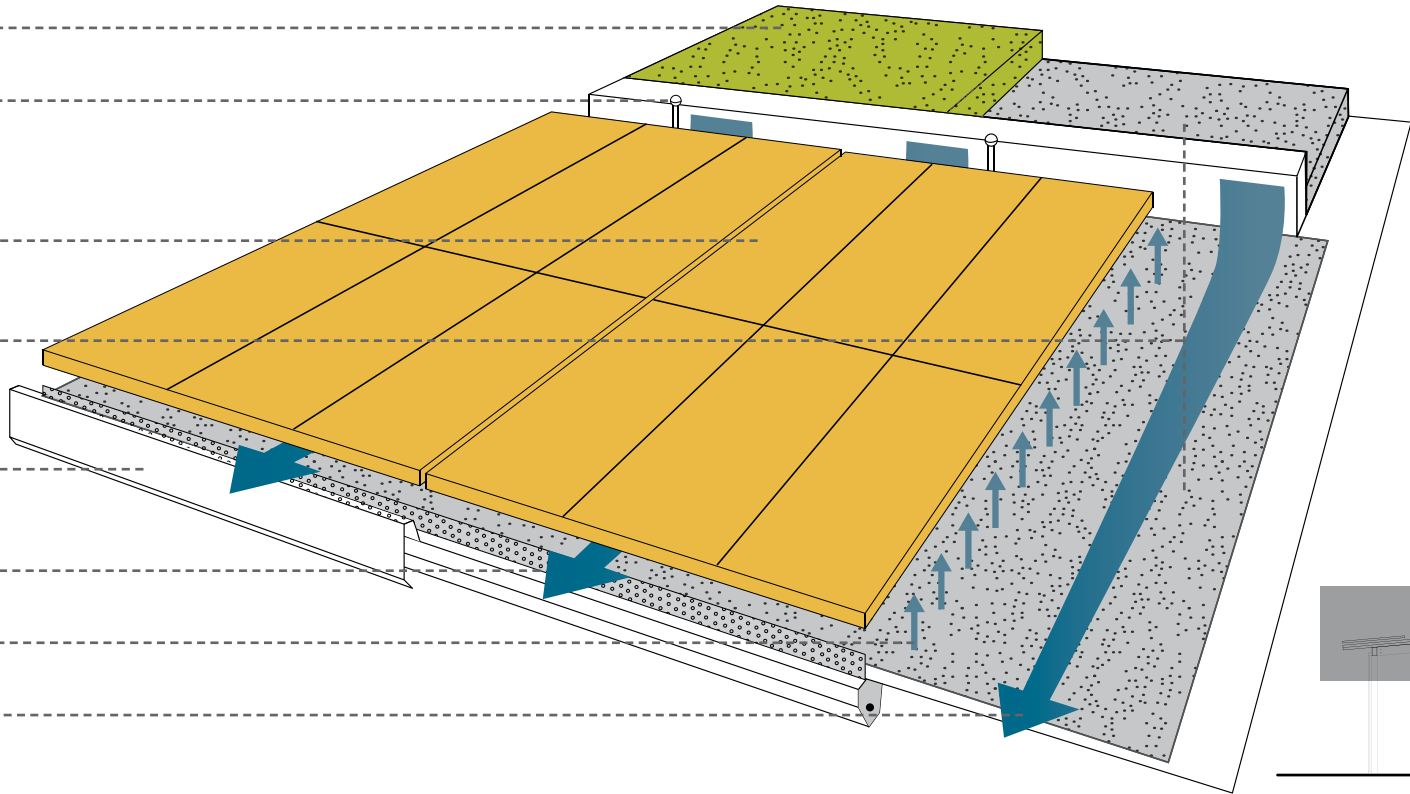
## cooling of photovoltaic plant by humidification

The cooling system is completed with a humidifying layer installed under the photovoltaic modules. This layer, composed of lvd 5/10 lapillus, is the homogeneous continuation of the drainage layer in the adjacent roof garden.

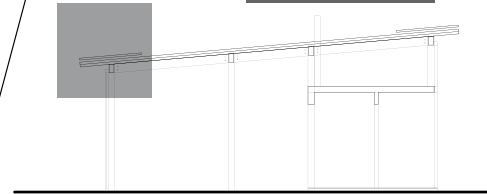
The humidifying layer is installed on the mechanical protection element in uniform layers along the entire length between the drainage pipe and the dripstone/ roof edge. The water is conveyed to the humidifying layer as follows:

- 1 Direct pluviometric supply from the ventilation space between the photovoltaic panel and the drainage pipe that contains the plant system.
- 2 Pluviometric supply and percolation from the plant system promoted by the permeability and draining capacity of the Np substrate and the underlying lvd 5-10 lapillus. The water flows through the drainage pipe and enters the humidifying layer.
- 3 Water supply from the subirrigation system. The humidifying layer has a capillary rise capacity of 26.6%, as well as excellent water retention capacity. The accumulated water subsequently evaporates, cooling the bottom of the photovoltaic panel. Evaporation increases significantly and becomes continuous especially in the summer, when the flow of hot, dry air further promotes the cooling process.

vegetation on  
Np substrate  
static  
irrigator  
photovoltaic  
panel  
lapillus lvd  
insulated  
structural  
fretted seam  
panel  
drainage  
profile  
evaporated  
water  
floating  
water



structure  
section





24  
genera

cycle 5  
water recovery  
and run off

The recovered water completes the cycle by returning to the accumulation pond of the pool through drainage pipes and is partially reused.

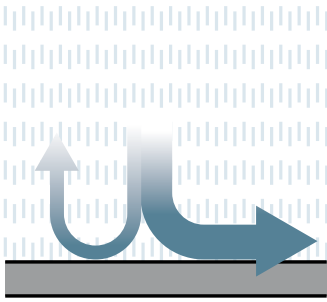
Thanks to percolation, infiltration, evaporation from the substrate, and evapotranspiration from the plants in the roof garden, the integrated system influences runoff generation by partially restoring the natural water cycle, thereby reducing the hydraulic load on the disposal network (delayed discharge of runoff compared to total absorption capacity of roof garden system) and thus reducing the need to build expensive purification systems and ground drainage channels.



t

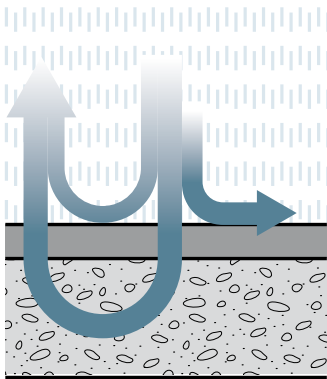
rain  
minimum evaporation  
ground

rain  
maximum evaporation  
NP substrate  
LVD lapillus

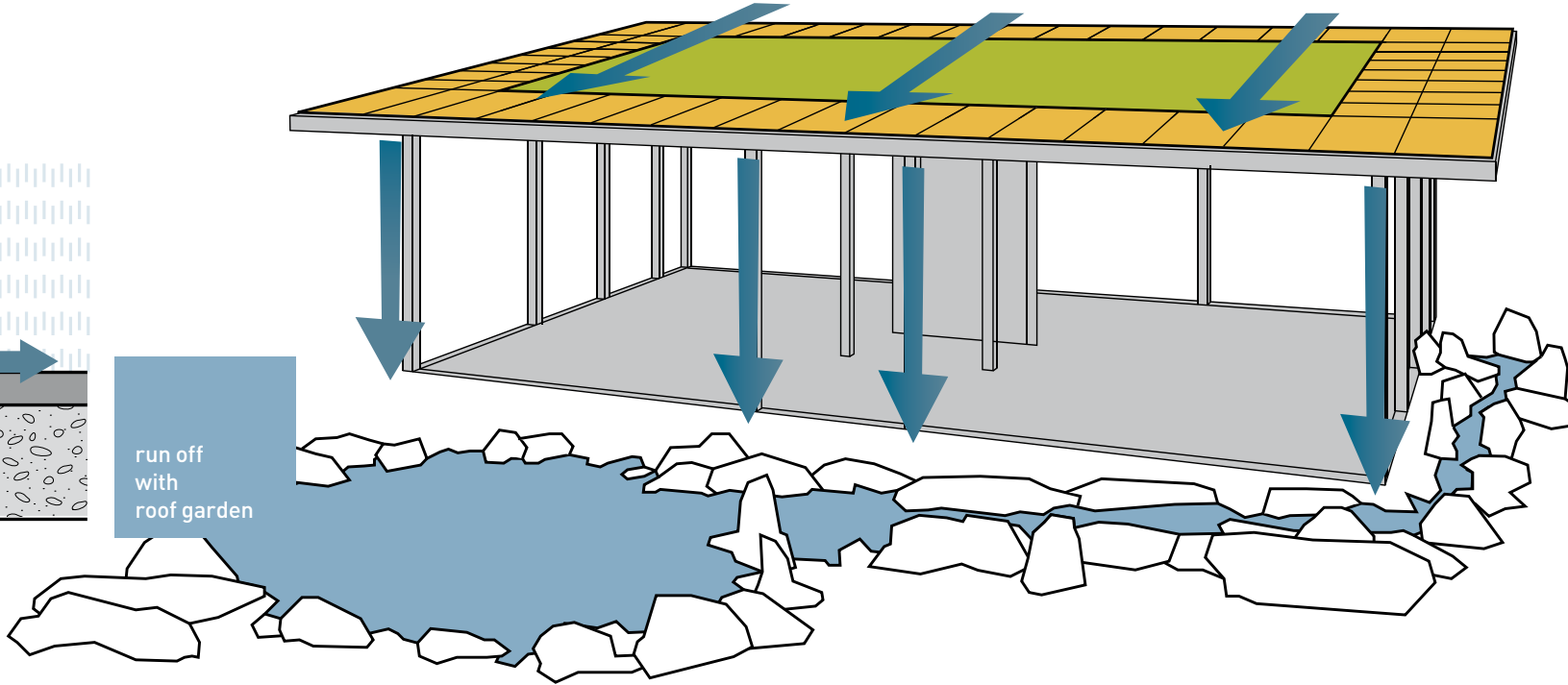


run off  
without  
roof garden

25  
genera



run off  
with  
roof garden







printed on Cyclus  
100% recycled paper



genera

via Bargellino, 8  
40012 Calderara di Reno (BO)  
tel. +39 051 72 73 24  
fax +39 051 72 94 18  
[info.generasistema.it](mailto:info.generasistema.it)  
[www.generasistema.it](http://www.generasistema.it)

Genera prototype  
via Casteldebole 10/4, Bologna