

# INNOFARM™ SYSTEM

The system called INNOFARM™ (hereinafter also the System) is applicable both to existing and newly built photovoltaic systems, both for installations on fixed structures and on solar trackers.



Currently, all the Regions and in any case the public administrations that issue authorizations for the construction and operation of photovoltaic systems built on agricultural land require integration between the production plant and the soil on which these same systems are built. The solutions adopted nowadays consist of planting various plant species between the spaces left free by the system and around the fence, with the consequence that the land underneath the photovoltaic modules is not exploited. The shading condition found under the photovoltaic panels, regardless of whether fixed structures or solar trackers have been installed, does not allow the cultivation of crops that require a certain degree of sunshine.

Given the above premise, the INNOFARM™ system solution allows the environmental conditions present before the installation of the system to be preserved even underneath the photovoltaic modules themselves, contrary to what happens nowadays. The application of the System therefore allows you to grow vegetable crops as if they were in an open field, with the only limitation of a maximum height.

The INNOFARM™ system is an application of already existing technologies, used in an integrated manner. The innovative aspect is identified in the use of these technologies with the aim of obtaining similar sunshine and humidity conditions found in the open field beneath the photovoltaic panels.

In addition to the aspect of exploiting 100% of the land occupied by the photovoltaic system (to date a condition which has not occurred in any real case) the System also allows the efficiency of the photovoltaic panels to be increased through an integrated cooling/irrigation system which is explained in the following paragraphs.

Therefore, the benefit would be twofold: total use of the land occupied by the photovoltaic system, therefore no "consumption of agricultural land", and increase in the production of renewable energy, combining agriculture with the production of electricity produced from renewable sources.

The impacts and integration of the System with the main elements of agriculture are described below: (i) lighting and (ii) irrigation.

## Lighting system and sunlight transmission

The fundamental factor for the growth of plant species is undoubtedly the presence of sunlight. The INNOFARM™ system allows up to 89% of the captured sunlight to pass through the glass surface that is part of the system. The innovative solution consists in the installation of particular glasses with very high transparency, with the interposition of a special foil diffusing sunlight, to replace a minimum portion of the photovoltaic system (approximate ratio 1:6).

Based on the crop that you want to grow underneath the photovoltaic system, the optimal ratio between the surface of diffusing glass and the photovoltaic panels will be calculated (usually the ratio between the glass surface and the surface of the photovoltaic panels is between 0.1 and 0,3).

## Lighting system and sunlight transmission

The fact of allowing sunlight to spread even if it affects only the part occupied by these glasses allows us to conserve an important surface area of the photovoltaic panels and therefore of renewable energy produced. In essence, the system and the installation configuration allow for environmental conditions suitable for cultivation for the entire surface underneath the photovoltaic panels.

In the event that the chosen crops require greater solar radiation than is available, the system can be equipped with ad hoc LED lamps, of the same type as those used inside greenhouses, suitable for open field cultivation. The management of this lighting system is guaranteed through irradiation sensors present at the surface level of the photovoltaic panels and underneath them, in such a way as to be able to recreate under the photovoltaic panels the same lighting and irradiation conditions present on the surface of the photovoltaic panels.

# Irrigation and Cooling System for Photovoltaic Modules

Another vital element in agriculture is water. The INNOFARM™ System includes the integration of an irrigation system controlled by soil humidity sensors and adjustable via timer or manual settings. The innovative aspect of this system consists in the use of water useful for irrigating crops also for cooling the photovoltaic panels. That is, the water used to feed the plants is, in part or totally, first nebulized above and below the surface of the photovoltaic panels, with the consequent cooling of the same, and then falls by gravity onto the agricultural crops below.

The beneficial use of the photovoltaic system does not imply any additional expense as the same water would still be used for agricultural use. The system directs the water directly onto the lower surfaces of the photovoltaic panels, via nozzles that allow it to be atomised, thus increasing the cooling power. Considering that the photovoltaic panel loses efficiency as the temperature on the surface of the module increases, a panel cooling system would therefore make it possible to increase the producibility of the system by approximately 0.35% for a decrease of one degree Celsius (i.e. by lowering the temperature of the panel surface from 50 to 35 degrees there would be an increase in production equal to 4.5%).

# Irrigation and Cooling System for Photovoltaic Modules

The water that was used to cool the panels will then fall directly below the photovoltaic panels, irrigating the planted crops. The humidity of the soil beneath the system is monitored via hygrometers which communicate with the irrigation system and therefore send on and off signals to it.

The monitoring also includes surface temperature sensors in the panels and also in this case the system acts in total autonomy to optimize the system's production and water supply to agricultural crops. In practice, the system decides whether and when to activate the water pump when one of the recalled parameters exceeds a certain limit and the other is within a tolerance range.



The INNOFARM™ system can be applied to any photovoltaic system installed on agricultural land to allow the use of the underlying land. As regards new photovoltaic systems to be built on agricultural land, the INNOFARM™ System allows us not to take away land from agriculture and at the same time use cultivated surfaces to produce energy from renewable sources. This undoubtedly has a positive impact on the concept of simultaneous use of agricultural land and would certainly be considered by Public Administrations as a solution to the problem of the subtraction of agricultural land for energy purposes.

Furthermore, in cases in which the proposed systems are installed, there could be an increase in cultivated land, in the event that the chosen land is uncultivated and is then put back into production following the adoption of the INNOFARM™ system.

The INNOFARM™ system is therefore composed of the following components:

- Photovoltaic panels, widely available on the market;
- Special glasses that diffuse incident sunlight, currently available on the market;
- Irrigation system with application of nebulizers, widely available on the market;
- LED system for crops, equipped with lighting sensors, widely available on the market;
- Monitoring and sensor system, widely available on the market.

The INNOFARM™ system is in summary an innovative system, protected by an Italian patent application and in the process of being granted at a European level, characterized by the integration of various components present on the market today. Its advantages and innovative features can be summarized in this way:

1. Use of 100% of land occupied by photovoltaic systems, both already installed and newly developed;
2. Reproductions of the environmental conditions beneath the plant with consequent use of the land for agricultural production;
3. Exploitation and re-cultivation of agricultural land left uncultivated;
4. Innovative combination of existing technologies, functioning automatically also thanks to a specific control system, which leads to an increase in the production of renewable energy and a greater cultivated agricultural surface.

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