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Overview on the Guide Lines published by the Ministry of Ecological Transition in 2022 on the agri-voltaic plants

I] DEFINITIONS

On June 27, 2022, the Ministry of Ecological Transition ("**MITE**") published the "*Guide Lines on agri-voltaic plants*", which provides for some important agri-voltaic plants' requirements (the "**Guide Lines**").

Such document has been drafted by a working group coordinated by MITE and composed by:

- Council for Agricultural Research and Analysis of Agricultural Economics ("*Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria*"- "**CREA**");
- Energy Service Manager ("*Gestore dei servizi Energetici*" - "**GSE**");
- National Agency for New Technologies, Energy and Sustainable Economic Development ("*Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile*" – "**ENEA**");
- Research on the Energy System S.p.A. "*Ricerca sul sistema energetico S.p.A.*" – "**RSE**").

According to the definition provided by MITE, the agri-voltaic plant consist in a "*photovoltaic system that adopts solutions in order to preserve the continuity of agricultural and pastoral cultivation's activities on the installation site*".

As well as the concept of agri-voltaic plants ("*simple agri-voltaic plant*"), MITE introduced also two additional concepts:

- **advanced agri-voltaic plant:** i.e. agri-voltaic plant that, according to Art. 65 par. 1-quater and 1-quinquies of the Law Decree no. 1 of January 24, 2012, converted in Law no. 27/2012 as amended, ("**LD 1/2012**"):

i) adopt innovative integrative solutions with the assembly of the modules elevated from the ground, also providing for the rotation of the modules themselves, however, so as not to compromise the continuity of agricultural and pastoral cultivation's activities, also allowing the application of digital and precision agriculture tools;

ii) provides for the concomitant implementation of monitoring systems to verify the impact of photovoltaic installation on crops, water savings, agricultural productivity for different types of crops, continuity of activities of relevant farms, recovery of soil fertility, microclimate, climate change resilience;

- **advanced agri-voltaic system**: i.e. a complex system composed by the works necessary to carry out agricultural activities in a given area and an agri-voltaic plant installed on such area, which, through a spatial configuration and appropriate technological choices, integrates agricultural activity

and electrical production, and which aims to enhance the productive potential of both subsystems (agricultural and electrical), ensuring the continuity of agricultural activities of that area.

II] TECHNICAL REQUIREMENTS

According to par. 2.2. of the Guide Lines, technical requirement to build an agri-voltaic plant change depending on the type of plant. More precisely. MITE provides for 5 different requirements:

- **requirement A):** adoption of a spatial configuration and appropriate technological choices, such as to enable the integration of agricultural activity and electrical production and enhance the production potential of both subsystems;
- **requirement B):** synergic production of energy and agricultural products without compromising the continuity of agricultural and pastoral activities;
- **requirement C):** adoption of innovative integrated solutions for plants with elevated modules from the ground, aimed at optimizing both energy and agricultural performance;
- **requirement D)**: monitoring system to verify the impact on crops, water savings, agricultural productivity for different types of crops, and the continuity of activities of relevant farms;
- **requirement E)**: monitoring system that, in addition to requirement D, enables the verification of recovery of soil fertility, microclimate, climate change resilience.

Please find an overview of the above mentioned requirements according to Guide Lines as follows.

- **REQUIREMENT A "adoption of a spatial configuration and appropriate technological choices, such as to enable the integration of agricultural activity and electrical production and enhance the production potential of both subsystems"**

Some constructing and spatial conditions are simultaneously required in order to meet requirement A. In particular, the following parameters:

A.1) Minimum cultivated area: there is a minimum area dedicated to cultivation;	According to Guide Lines, at least 70% of total surface should be intended for agricultural activities, as per the following calculation: $agricultural\ surface \geq 0{,}7\ of\ total\ surface$
A.2) Land Area Occupation Ratio ("LAOR"): ratio of the total footprint surface of the agri-voltaic system ("**Spv**") to the total surface occupied by the agri-voltaic system ("**S tot**"). The value is expressed as a percentage.	According to Guide Lines, such value shall not exceed the limit of 40%.

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- **REQUIREMENT B "synergic production of energy and agricultural products without compromising the continuity of agricultural and pastoral activities"**

Guide Lines require the compliance with the following parameters in order to meet requirement B:

B.1) continuity of agricultural and pastoral activities on the lands involved	It must be valued: **(i) value of the agricultural production** on the area intended for agricultural system during the calendar years following the entry into operation of the system expressed in €/ha o €/UBA (Adult Livestock Units, "*Unità di Bestiame Adulto*"), comparing it with the average value of agricultural production recorded on the area intended for the agri-voltaic system in the preceding calendar years, with the same production address. In the lack of agricultural production in the preceding calendar years, Guide Lines suggest to refer to the average productivity of the same agricultural production in the geographical area subject to the installation. Alternatively, it is possible to monitor the data by providing for a control zone, which would produce an estimate of production on the land underlying the plant; **(ii) maintenance of the production address**: if there is already a cultivation of a farm, the production address should be maintained or, eventually, a new production address having a higher economic value could be adopted. PDO or PGI production must be maintained[1].
B.2) minumum electrical producibility:	the electrical production of an agri-voltaic plant (agri-voltaic in GWh/ha/year) correctly designed, compared to the electrical producibility of a standard photovoltaic system (PVstandard in GWh/ha/year), should not be less than **60 %** of the latter: $Agri\text{-}voltaic \geq 0{,}6 \cdot FVstandard$

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- **REQUIREMENT C "adoption of innovative integrated solutions for plants with elevated modules from the ground, aimed at optimizing both energy and agricultural performance"**

The area intended for cultivation or livestock activities may coincide with the entire area of the agri-voltaic system or be reduced to a part of it, as a result of the spatial configuration choices of the agri-voltaic plant.

[1] The economic value of a production address is measured in terms of standard production's value calculated at the overall farm level; the method of calculation and the definition of standard production coefficients are prepared as part of the FADN Survey for all farms accounted for. For example, a possible conversion of agricultural activity from an intensive address (e.g., horticulture) to a much more extensive one (e.g., arable crops or pasture meadows), or the abandonment of activities characterized by PDO or DOCG marks, do not meet the parameter of maintaining a production address.

In the regard, Guide Lines provides for three examples of solutions: only plants of example n. 1 and 3 meet requirement C.

EXAMPLE 1: the minimum height of the modules is designed to allow the continuity of agricultural (or livestock) activities even under the photovoltaic modules. A condition is configured in which there is a dual land use, and a maximum integration between the agri-voltaic system and the crop, and that is, the PV modules perform a synergistic function to the crop, which can be expressed in the protection of the crop (from excessive sunlight, hail, etc.) accomplished by the photovoltaic modules. In this condition, the surface area occupied by the crops and that of the agri-voltaic system coincide, without prejudice for the constructive elements of the plant that rest on the ground and inhibit activity in circumscribed areas of the soil.	It meets requirement C
EXAMPLE 2: the height of the modules from the ground is not designed to allow agricultural activities below the photovoltaic modules. There is a combined land use, with a lower degree of integration between the photovoltaic plant and the crop than the previous example (since the photovoltaic modules do not perform any synergistic function to the crop).	It does not meet requirement C
EXAMPLE 3: photovoltaic modules are placed in a vertical position. The minimum height of the modules from the ground does not significantly affect the chances to cultivate ì (except for shading at certain times of the day), but it may affect the degree of connectedness of the area, namely the possible passage of animals, with implications on the use of the area for livestock activities. In contrast, the integration between the agri-voltaic system and the crop can be explicated in the protection of the crop accomplished by the photovoltaic modules acting as windbreaks.	It meets requirement C

Given the minimum height of photovoltaic modules on fixed structures and the average height of modules on mobile structures, in case of configurations where agricultural activity is also carried out below the modules, the following reference values have been set for the purpose of falling within examples 1) and 3):

- 1.3 meters in the case of livestock's activity (minimum height to allow the continuous passage of livestock);

- 2.1 meters in the case of cultivation's activity (minimum height to allow the use of machinery functional to cultivation).

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- **REQUIREMENT D "monitoring system to verify the impact on crops, water savings, agricultural productivity for different types of crops, and the continuity of activities of relevant farms"**

Requirement D is met in case of the following parameters occur:

D.1: monitoring of water saving: provide specific supplementary solutions that pay attention to water use efficiency (water saving systems and runoff water management).	Guide Lines provides for three types of systems: **(i) Self-supply:** water use can be measured by the volumes of water from reservoirs/tankers withdrawn through batch pumps or by meters placed on farm wells or points of withdrawal from streams or reservoirs, or by knowledge of the granted flow rate

	(l/s) present on the deed of concession to derive along with the time of operation of the pump; **(ii) Irrigation service:** water use can be measured through fiscal counters/meters at the farm system inlet and on the dedicated irrigation by-pass of the agri-voltaic system, or also through data in the National Information System for Agricultural Water Resources Management ("*Sistema informativo nazionale per la gestione delle risorse idriche in agricoltura*" - "**SIGRIAN**"); **(iii) Mixed:** whose water consumption can be measured through the arrangement of both of the above mentioned metering systems. In order to monitor the use of the water resource for irrigation purposes, it would also be necessary to know the previous situation related to neighbouring areas cultivated with the same crop, under ordinary growing conditions and in the same period, so as to be able to compare reference irrigation requirement values with the current ones and evaluate their optimization and enhancement, through the joint use of SIGRIAN and the "Agricultural Accounting Information Network" ("FADN") databases. Farms in the RICA sample that fall within SIGRIAN irrigation districts can be considered potentially irrigated with consortium water as they can be reached by consortium irrigation infrastructure, those outside irrigated by self-supply. Mixed are identified with an additional level of analysis of FADN-SIGRIAN data. The Guide Lines also recommend compliance with the technical indications contained in the "*Guidelines for the Regulation by the Regions of the Methods for Quantifying Water Volumes for Irrigation Use*" ("*Linee Guida per la regolamentazione da parte delle Regioni delle modalità di quantificazione dei volumi idrici ad uso irriguo*").
D.2 monitoring of the continuity of agricultural activity	Guide Lines provides for the draft of a technical report certified by an agronomist "*with an established cadence*" in order to monitor: **- the existence and performance of cultivation;** **- the maintenance of productive address.** Annual cultivation plans may be attached to the report, bearing details of the species annually cultivated, the surface actually intended for cultivation, the growing conditions of the plants, and cultivation techniques (planting sixth, seeding density, use of fertilizers, phytosanitary treatments).

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- **REQUIREMENT E "monitoring system that, in addition to requirement D, enables the verification of recovery of soil fertility, microclimate, climate change resilience"**

Lastly, Guide Lines provided for the compliance with the following parameters in order to meet requirement E:

E.1. monitoring of recovery of soil fertility:	Guide Lines provide for the draft of the same technical report certified as per previous requirement D.2.
E.2 monitoring of microclimate	Such monitoring should be carried out through: temperature, relative humidity and air velocity sensors along with radiation measurement sensors placed below the photovoltaic modules and, for comparison, in the area immediately adjacent to but not covered by the plant. In this regard, Guide Lines suggest to monitor: - the outdoor ambient temperature (acquired every minute and recorded every 15 minutes) measured with sensor (preferably PT100) with uncertainty less than ±0.5°C; - the back-module temperature (acquired every minute and recorded every 15 minutes) measured with sensor (preferably PT100) with uncertainty less than ±0.5°C; - back-module and sternum ambient air humidity measured with hygrometers/psychrometers (acquired every minute and recorded every 15 minutes); - the air velocity back-module and outdoor environment, measured with anemometers. The results of such monitoring can be recorded, for example, through a three-year report drafted by the proponent.
E.3 monitoring of climate change resilience	For this purpose, it is prescribed that: - at the design stage, the preparation of a report containing the analysis of physical climate risks according to the location, identifying possible adaptation solutions, is required; - at the monitoring stage, the provider must verify any incentives of the implementation for climate adaptation solutions which have been identified in the report mentioned in the previous point (e.g. by requesting documentation, including photographic documentation, of the construction site phase and the final artifact).

In the light of the above, according to Guide Lines:

(i) requirements A, B e D.2 should be met in order to build a simple agri-voltaic plant.

(ii) requirements A, B. C e D should be met in order to build an advanced agri-voltaic plant.

(iii) requirement A, B, C, D ed E should be met in order to access to contributions of PNRR.