Energy transition: an analysis of agrivoltaic utilities suitability in terms of Levelized Cost of Electric Energy.

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Overview

Utility scale photovoltaic plants require large land extensions: for a ground mounted system a power density of 80W/m^2 may be considered typical at our latitudes (Bolinger M,2021). This in turn means that the larger and larger utilities that are being installed all over the world ask for plot of lands in the range of several hectars. And, as a result, the production of electric energy from photovoltaic is being conflicting with other land uses such as agricolture. In order to mitigate the competition of these two production activities over land control, innovative photovolatic plants, so called agrivoltaic, capable to allow farming activities and energy production are being developed. In this work the LCOE of agrivoltaic plants defined according to the current italian legislation, will be evaluated and compared with that from standard non innovative PV plants. Results show LCOE from agrivoltaic plants is at least 30% higher. Even more relevant, it is shown that several issues related to agrivoltaic implementation are still poorly understood or unknown at all, so that such technological solutions for large utilities should be carefully considered by goverments and stakeholders in terms of their role in the energy transition. Probably, at least at this stage of development, only agrivoltaic installation in abandoned agricoltural lands should be preferred.

Methods

LCOE, defined as the ratio between the agrivoltaic plant cost and the electric energy produced in its total lifetime will be evaluated. In this paper the expression for *LCOE* defined by Vartiainen and coworkers (Vartiainen E., 2020) for large PV plants will be used:

$$LCOE = \frac{\left(CAPEX_{PV} + \sum\left[\frac{OPEX_{PV}(t)}{(1+WACC_{nom})^t}\right] + \frac{InvRepl}{(1+WACC_{nom})^{N/2}} - \frac{ResVal}{(1+WACC_{nom})^N}\right)}{\sum\left[\frac{Yield(0)\times(1-d)^t}{(1-WACC_{real})^t}\right]}$$

where N is lifetime of the PV system, t is the year number ranging from 1 to N, $CAPEX_{PV}$ is the total capital expenditure of the system, made at $t = 0$ in EUR /kWp, $OPEX_{PV}(t)$ is the operation and maintenance expenditure in year t in EUR /kWp, InvRepl is the cost of the inverter replacement, made at $t = N/2$ in EUR /kWp, ResValue is the residual value of the system at $t = N$ in EUR /kWp, Yield(0) is the initial annual yield in year 0 in kWh/kWp without degradation, d is the annual degradation of the nominal power of the system, $WACC_{nom}$ is the nominal weighted average cost of capital per annum and $WACC_{real}$ is the real weighted average cost of capital per annum. For Capex and Opex costs data from scientific literature and interviews to italian operators, have been used (Di Francia G. 2023).

Results

The analysis performed shows that the energy cost by the agrivoltaic solutions are much higher than the cost of the energy produced by standard non innovative PV plants so that supporting prizes or suitable FiTs schemes are to be adopted if such solutions are to be fostered. On the other hand the revenues from the cropland activity for land unit, are, in general, quite negligible with respect to the electric energy revenues and, morever, that activity can negatively affect the electric energy production so that, the risk of a further land abandonment cannot be neglected.

Conclusions

At current CAPEX ad OPEX costs, agrivoltaic should be first of all considered for abandoned lands, using financial supporting schemes to reduce the negative impact of such a problem on agriculture and on the social texture.

References

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