

Studies on an experimental test facility for the rising energy micro-communities

The Renewable Energy Directive (RED) and the inherent recent update (EU/2018/2001 - EU/2023/2413) promote the uptake of renewable energy communities (RECs) and Jointly Acting Renewable Self-Consumers (JARSCs) for the local production and shared consumption of energy, as an alternative to the classic model based on centralized production, transmission, and distribution. The rising of RECs and JARSCs allows rethinking the morphological organization of land from an ecological perspective, for cities increasingly designed on a human scale. Renewable energy sources (RESs) are fundamental for the diffusion of the rising RECs, where Photovoltaic (PV) is the most employed technology, due to its performance, application flexibility, longevity, and affordability. Since RESs provide intermittent power production and the energy demand of consumers is growing and becoming more variable, the application of Demand Side Management strategies, such as the load shifting operated by storage systems, is urgent to maximize the energy self-consumption (SC) and self-sufficiency (SS) of RECs. We conducted an extensive experimental study on an energy micro-community consisting of a building served by a 12 kW PV system and a heat pump (HP) combined with hot/cold water and Domestic Hot Water storages, controlling the production, storage and use of electrical and thermal energy by means of a Programmable Logic Controller (test facility S.A.P.I.EN.T.E. located in ENEA Casaccia)[1, 2]. We set up a power-to-heat strategy: by using a Proportional-Integral-Derivative control we tracked the power produced by the PV system and used it to drive the HP in real time, maximizing SC and SS, since the HP does not need to draw energy from the grid. The thermal energy produced in excess of the load (real or emulated) is stored. Thus, taking advantage of the high coefficient of performance of the HP used to produce and store thermal energy, we increased in value the electrical power coming from the PV. In our investigations, we demonstrated SS and SC values of 96.7% and 83% respectively, again emphasizing and promoting a new sustainable model of advantageous energy production and use.

- [1] B. Di Pietra, G. Landi, L. La Notte, A. L. Palma, and P. Sdringola, "Tecnologie e soluzioni per la gestione ottimizzata ed efficiente del sistema edificio-impianti," *Energia, ambiente e innovazione*, vol. 03, pp. 98-101, 2020.
- [2] A. L. Palma, L. La Notte, G. Landi, and B. Di Pietra, "Application of a demand-response-optimized electrical load profile to a plant supplying an energy micro-community," in *2022 Workshop on Blockchain for Renewables Integration (BLORIN)*, 2022, pp. 97-101.