Assessing the gains of a photovoltaic collective self-consumption from residential and tertiary buildings

Sylvain Cros[1], **Jordi Badosa**[1]

1. Laboratoire de Météorologie Dynamique, Ecole Polytechnique, Palaiseau Cédex, FRANCE, France

Objective & Background

Self-consumption contributes to the distribution grid stability by avoiding voltage rise during peak photovoltaic (PV) generation periods and helps to reach higher shares of installed PV in the electric mix [1]. It also offers a cheap and clean electricity to users.

As PV production profile does not fulfill single user consumption habits, a surplus must be valued. This excess can either be stored trough batteries (inducing energy loss and extra-costs) or be sold to an energy operator at regulated feed-in tariffs (generally less attractive than those the self-consumed energy). Another solution consists in PV production sharing between neighbored users. By gathering various consumer profiles (housing, office, store, industry) around a PV production unit, the surplus can be reduced without opting to undersized PV farms. The so-called “collective self-consumption” (CSC) have been defined in France since 2018 and is organized with the distribution system operator [2].

The purpose of this work consists in assessing the PV production surplus reduction by simulating a CSC operation including housing and tertiary building.

Method

Since October 2020, the start-up incubator of Institut Polytechnique de Paris (called Drahi-X Novation Center) is in self-consumption supplied by a rooftop PV farm of 17 $kW_{p.}$ PV production, grid extraction and electricity consumption of this building is recorded at high temporal resolution (1-second to 1-minute). The consumption of several surrounding buildings hosting staff and students are also available. Moreover, SIRTA atmospheric observatory [3], inside the same Campus, measures at his place the global horizontal irradiance (GHI) within the quality standards imposed by the Baseline Surface Radiation Network [4].

We simulated an “energy community” composed of several independent users in residential and tertiary during one year. The PV production data helped us to design fictional PV farms with the possibility of scaling their installed capacity. For this, PV measurements have been cleaned from incidental gaps and known biases (e.g. tree shadowing) using GHI measurements. The community has been modeled through two configurations: 1) users are connected to a collective PV plant or 2) each of them have its own individual PV farm (the sum of the individual capacities is equal to the one of the collective PV plant).

Principal Findings

The main results show that because of the difference between building and residential usages, there is a significant interest to be in a CSC configuration. Total surplus of the year 2022 has been CSC is more efficient is summer in the tested climate region.

Conclusion (or Discussion)

The interest of CSC has been quantified with our community modeling choices. However, these results raises questions for fair billing. In case of high PV production, the biggest consumers might have less economical advantages in a CSC mode wirh static distribution keys than in individual self-consumption. Further studies should be undertaken using PV production intraday forecasting associated to a suggested flexible demand.

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