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REDUCING BILLING GAP IN ENERGY COMMUNITIES VIA FORECAST-BASED SHARING COEFFICIENTS

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Abstract – Collective self-consumption (CSC) and energy communities increasingly rely on dynamic sharing coefficients to allocate photovoltaic (PV) generation among participants. In several regulatory settings, these coefficients must be communicated in advance (e.g., one month ahead) and may vary hour by hour. This creates a practical challenge: allocation ratios must be computed ex ante, while actual individual loads are only known ex post. Consequently, community-level costs and perceived fairness can become strongly dependent on the accuracy of month-ahead, hour-by-hour demand forecasts, particularly in residential settings where only historical smart-meter data are available. This paper proposes a transparent forecasting-and-allocation framework to compute regulation-compliant hourly sharing coefficients under a strict no-look-ahead protocol. The method follows a two-step approach. First, each participant's hourly consumption for the forthcoming month is predicted using simple, interpretable persistence-type models capturing complementary patterns: previous-month hour-of-day profiles (PM), the same calendar month in the previous year (PY), rolling multi-month hour-of-day profiles (ROLL), and a weekly seasonal profile (SP). Second, forecasts are combined through an ensemble (ENS) that learns hour-of-day–specific weights from recent forecast errors via inverse-variance weighting, enforcing a sum-to-one constraint. The resulting individual forecasts are normalized across participants at each hour to obtain the dynamic sharing coefficients, which are then applied ex ante to allocate PV generation during the subsequent month. The framework is evaluated in a realistic CSC case study with 15 residential customers under Spain's regulated PVPC 2.0TD tariff, using hourly demand from real smart-meter data and PV production from PVGIS for a 25 kW plant in Seville (Spain). Performance is assessed through the annual "gap to baseline", defined as the relative excess annual bill with respect to a perfect-information benchmark based on ex post optimal allocation (used only as a reference). Results show that the ensemble achieves the smallest excess cost among practical methods, at approximately +5.3 % above the baseline. Alternative practical predictors exhibit larger gaps, ranging from about +6.1 % (SP) to +10.7 % (PY), with intermediate values of ~+8.4 % (ROLL) and ~+9.0 % (PM). In terms of gap reduction, ENS decreases the excess cost by roughly ~12 % versus SP, ~36 % versus ROLL, ~40 % versus PM, and ~50 % versus PY.

Keywords – Collective self-consumption; dynamic sharing coefficients; electricity demand forecasting; forecasting ensemble; renewable energy regulation; seasonal decomposition

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