155

The social contract of energy sharing communities: ensuring fairness through allocation rule design

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Extended Abstract

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Abstract Summary

The decentralization of energy systems has positioned renewable energy communities as key instruments in Europe's clean energy transition. Among their organizational models, collective self-consumption (CSC) enables participants to share locally generated renewable electricity through predefined allocation rules, while retaining individual retail contracts. In France, CSC operates as a community-based, ex-post value allocation scheme: a fixed local energy tariff is agreed upon ex ante, and shared energy quantities are distributed among members according to an allocation rule. Due to its administrative simplicity, this default "pro-rata" rule — which allocates shared energy proportionally to each member's real-time net demand — is adopted by the vast majority of French energy sharing communities. While it minimizes by design the avoidable locally non-allocated renewable energy, it may generate unfair benefit distributions and create perverse behavioral incentives, particularly when participants possess large flexible capacities and share similar objectives.

This paper investigates how allocation rule design affects physical and financial dispatch outcomes, as well as perceived fairness, in a fully decentralized CSC community where participants act without cooperation. We formulate a generalized Nash equilibrium problem in which each participant maximizes a multi-dimensional utility function capturing economic, environmental, and self-sufficiency-oriented preferences. Four allocation mechanisms are compared: static equalitarian, pro-rata, minimax, and a centralized benchmark. We evaluate the outcome dispatches against quantitative egalitarian and Rawlsian fairness indicators. Using an empirical French case study grounded in monitored household electricity consumption data, we quantify benefit distributions and fairness outcomes across participant profiles and motivation scenarios.

Results confirm that proportional dynamic allocation systematically favors larger consumers and can generate herding effects leading to paradoxical midday peak loads. By contrast, the Rawlsian minimax allocation emerges as a compelling alternative: it preserves

high local self-consumption, suppresses undesired rebound effects, and yields benefit distributions perceived as significantly fairer.

Presenting Author Biography

Kamil Takhi holds an engineering degree (MSc) and a specialized master's (MS) degree in energy economics, with expertise in the field of power systems. He is currently a second-year industrial PhD candidate in collaboration with EPEX SPOT, the European Power Exchange, RTE, the French Transmission System Operator, and the Sustainable Economy research group at CentraleSupélec.

His doctoral research investigates the integration of energy communities into the European power system, both from a market and system operator's perspective. The findings are expected to contribute to the evolution of power regulation and market design.