Hourly Energy Model of Residential Health Care Facilities for their Assessment in Renewable Energy Communities

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Abstract Achieving energy transition in urban areas requires innovative approaches that match renewable energy production with local consumption patterns while addressing social and economic sustainability. Renewable Energy Communities (REC) represent a strategic model for energy transition, enabling citizens, businesses, and public bodies to produce, consume, and share renewable energy. This promotes sustainable behaviours and greater responsibility towards efficient energy use, while creating new opportunities for innovation and decentralization.

This work focuses on the role of residential health care facilities (RSA, using the Italian acronym) within RECs. Even though RSAs are energy-intensive consumers and, therefore, can have a significant impact in local energy sharing, there is a gap in the literature as regards their energy modelling, while the adoption of generalized consumption profiles fails to properly capture their actual characteristics.

This paper presents a data-driven model implemented to create normalised hourly electricity consumption profiles for RSAs. The dataset used for this analysis includes real energy data from five facilities located in Northern Italy, with different size, number of beds and installed photovoltaic (PV) equipment. The methodology includes data preprocessing to remove inconsistencies, PV self-consumption assessment, and a custom interpolation algorithm for missing data. Representative normalized hourly load profiles are derived for each month, distinguishing between weekdays and holidays, and model validation shows maximum deviations below 25% compared to real data.

The resulting profiles have been integrated into the testing environment of RECON, an online simulation tool developed by ENEA aimed to assess the energy and economic performance of RECs according to the current Italian legislative and support schemes. Results demonstrate that a REC with RSA can achieve high levels of diffuse self-consumption and self-sufficiency when coupled with appropriately sized PV systems, alongside economic benefits that can be used to activate community services, thereby enhancing local welfare.

Therefore, this study aims at contributing to plan strategies for energy transition in cities and territories and shows how social welfare structures integrated into RECs can foster economic and social value, inclusivity, and long-term resilience and sustainability.