Characteristic load curves of positive energy districts

Fabian Ochs[1], Alice Tosatto[1], Elisa Venturi[1], Samuel Breuss[1], Mara Magni[1], Georgios Dermentzis[1], Carsten Wemhoener[2]

[1] University of Innsbruck, Innsbruck, Austria

[2] OST, Rapperswil, Switzerland

Abstract

The decarbonization of the building sector is linked to the electrification of buildings, thus, increasing the stress on the electric grid. The concept (or vision) of positive energy districts (PEDs) aims at supporting the energy transition in cities by fostering the development of both, planning processes and tools as well as technologies. Furthermore, the goal is to raise awareness about sustainable cities and to showcase the feasibility to reach a positive energy balance on the district level. While with improved efficiency of buildings, with heat pumps (HP) and on-site PV, a net positive energy balance is possible for new buildings, in existing or in high-density districts, reaching a positive energy balance on the footprint of the district is very challenging. Using a real case study from Austria and different archetype PEDs, electric load and supply curves are generated by means of dynamic simulation and are characterized with the aim to support decision-making in terms of minimum required energy efficiency level, HP system concepts and renewable energy integration. Even if the net energy balance is achieved, a significant gap in winter remains that has to be covered by the grid. Addressing the mismatch between energy demand in winter and RE generation in summer (so-called winter gap) is crucial for building a sustainable, affordable and resilient energy system. The grid stress cannot be relevantly reduced by increasing on-site PV and on-site storage but instead can be significantly limited by efficiency measures (electric peak load reduction by ca. 50 %) and is one of the most relevant KPIs to evaluate and optimize PEDs on the path to or transforming districts into PEDs.

Keywords: Positive energy district, Energy efficiency, Heat pump, Load curve, Renewable energy, Energy storage, Flexibility, Winter gap, Peak load

---

The paper was published in Solar Energy Advances as part of the EuroSun 2024 select papers.

https://doi.org/10.1016/j.seja.2024.100081