EGU21-7945, updated on 19 Jan 2022
https://doi.org/10.5194/egusphere-egu21-7945
EGU General Assembly 2021

Spatial and temporal variability in PV generation with respect to consumption patterns

Natasa Vulic, Martin Rüdisüli, and Kristina Orehounig
Empa, Dübendorf, Switzerland

In efforts to reduce the carbon intensity of electricity generation, optimizing the use of renewable energy necessitates an understanding of its spatial and temporal variability with respect to the corresponding consumption patterns. Their coupled analysis leads to identifying existing and anticipated discrepancies in supply and demand that can help to guide both the implementation of monitoring and control strategies to balance loads through demand-side management (e.g. shifting space heating, domestic hot water, EV charging) and storage (e.g. battery, thermal, and chemical), as well as plans for further expansion of renewable energy generation. In this study, we analyze PV production and consumption patterns (daily/weekly/seasonal) within and across different utilities for the case study in Switzerland. We analyze three utilities using (1) indicators to assess their PV production and utilization, (2) visualization techniques to observe the varying patterns in consumption and production across day/week/year, and (3) computational methods to balance production surpluses and deficits, estimating the necessary load-shifts for different PV production levels (regardless of the means of shifting this demand). In the first case, we assess balancing areas of different scales---from a handful of prosumers to a residential neighborhood to the full utility area---demonstrating an improvement in their capacity to accommodate higher shares of PV production. We attribute this improvement to reduced variability in aggregated supply and demand, together with the increased diversity in building use (residential, office, retail/restaurant, industrial, etc.). When comparing the production and consumption patterns across the three utilities, similarities in the shapes of the daily profiles, weekday/weekend consumption, seasonal variations (e.g. heating demand) and load-scheduling practices (e.g. domestic hot water charging) are observed. Nevertheless, we observe large differences in their ability to consume the produced PV electricity locally, which appear related to their building stock composition, PV installation types (residential vs commercial), as well as access to higher grid hierarchy levels. These differences demonstrate the need for locally tailored strategies to expand PV production while ensuring their adequate utilization. The general methods and approach presented here aim to assess these differences and inform more effective implementation strategies needed to reach ambitious national renewable energy targets.