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How do climate change and efficiency enhancement influence the self-consumption rates and grid flows of residential energy systems with PV-coupled battery systems?

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The utilization rate of residential PV-coupled battery systems is determined from the domestic energy consumption on the one hand and the excess production of the power plant on the other hand. Both factors will undergo significant changes in the near term future due to climate change and efficiency enhancement. In our study, we assess their impacts on the number of battery cycles, but also the grid flows, and self-consumption rates of the households.
The analysis is carried out with a domestic energy system model consisting of a consumption, a PV-production, and an accumulator component. This approach is embedded into the physically based land surface process model PROMET using a grid resolution of 100 m with an hourly time step. The selected charging strategy of the battery systems maximizes both self-consumption and grid relief effects by using a daily, dynamic feed-in limitation with perfect forecast.
The study region covers three administrative districts located in the south of Bavaria with a total population of 300,000 people. Four meteorological and efficiency scenarios in 2045 are analyzed for 4,706 domestic energy systems: The basic scenario uses measurement data for the meteorology and the energy consumption from 2016. Scenario A) is based on the meteorological conditions of RCP 8.5 and no efficiency enhancement; scenario B) assumes RCP 4.5 and a decrease by 17 % and scenario C) RCP 2.6 with a decrease of the energy consumption by 19 %.
The simulations results show, that all three future meteorological scenarios increase the annual energy production of the PV-plants by 15 %. In addition, the power excesses and the utilizations of the batteries will rise for in the year 2045. The highest increase in the feed-in and self-consumption rates is obtained in scenario A) using RCP 2.6 and a decrease of the energy consumption by 19 %. The obtained results of all three scenarios demonstrate that grid operators have to expect rising numbers of bottlenecks if no adjustment measures are applied.