Strategies and tipping points for individual and communal residential PV-battery systems in Luxembourg

Executive summary

In the context of the renewable energy transition, a growing interest in residential battery storage from prosumers and policymakers can be observed. Residential batteries can increase the self-consumption of locally produced PV electricity, they can reduce the electricity bill of prosumers, and they can contribute to relieving the electricity grid and integrating more renewables if controlled accordingly. This makes them an interesting technology for individuals, as well as for society.

Numerous studies have analysed the economics of residential PV-battery systems, however, a large number of assumptions play a role in this kind of investigation, which makes the situation in every country unique and prevents universal conclusions. This study analyses the technical and financial performance of individual and communal residential batteries specifically in Luxembourg. It is the result of a masters graduation project at the Eindhoven University of Technology, carried out in cooperation with the Klima-Agence in Luxembourg.

The main research objective is to identify tipping points for the financial profitability of residential batteries specifically in Luxembourg. Lithium-Ion Batteries for individual households as well as energy communities are analysed. Moreover, it is analysed how the profitability of batteries is affected by different electricity tariff structures as well as the use of heat pumps and electric vehicles.

To this end, a simulation model is developed to determine the power flows in residential PV-battery systems. Electricity consumption data from real Luxembourgish households is used and paired with weather data to determine PV production. A flat electricity tariff, as mostly used nowadays, a time-of-use tariff, where the energy price varies depending on the time of the day, and a subscription-based tariff, that penalises power peaks outside of a specific subscribed capacity are considered. The financial savings generated by the battery storage are compared to the investment costs of battery systems, to determine the profitability of such systems.

The results show that residential battery storage is not profitable under the current price conditions regarding electricity and investment costs. The most favourable tariff structure is the time-of-use tariff, while the flat tariff with the subsidised feed-in tariff is the least favourable. The subscription-based tariff is the most grid-friendly, but the fixed network costs reduce the financial advantage attainable by increasing the self-consumption, thus leading to generally low profitability. Community storage is more profitable than individual storage because investment costs per kWh capacity sink with the size of the battery. While the self-consumption of a community is higher than the individual self-consumption, the increase generated by the battery is similar in both cases. The financial advantage is thus only caused, by the proportionally lower investment costs.

With today's electricity prices, the battery price would still need to drop at least to 40% of the current level, or a subsidy of 60% of the investment would be necessary for the battery to become profitable. With rising electricity prices, the tipping point for the battery price gets higher. For the largest community, batteries at the current price start to become profitable at electricity prices of 0.35 €/kWh. For individual HHs the average electricity price would need to increase to at least 0.60 €/kWh at current battery prices.