# Energy Analysis Platform

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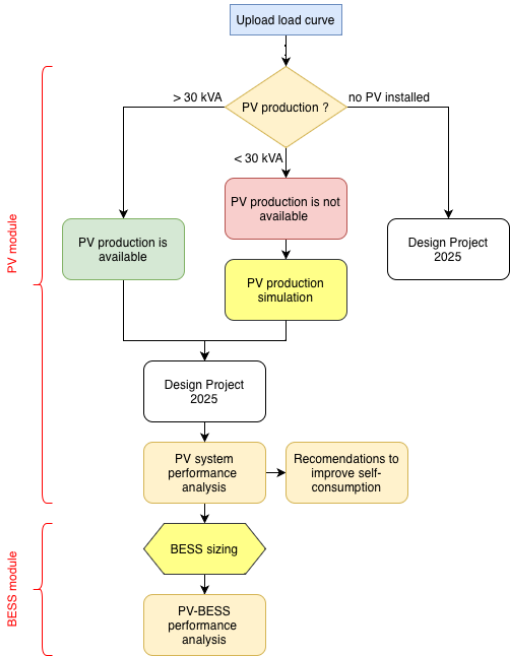
The growing deployment of residential photovoltaic (PV) systems is transforming electricity consumers into “prosumers” (a contraction of producers and consumers), creating new challenges related to self-consumption and energy management. To address these challenges, this project extends the DataWatt energy-analysis platform with two new modules dedicated to PV systems and battery energy storage system (BESS) sizing.




*Workflow of the DataWatt platform including PV and BESS modules. “Design Project 2025” refers to the existing consumption-analysis module developed in the context of a previous Design Project, which analyses the uploaded load curve, extracts consumption indicators, compares the user with similar consumption. The present project builds on this existing workflow.*

The PV module integrates PV production into the existing DataWatt workflow. When production measurements are unavailable, which is typically the case for residential installations below 30kVA, a pvlib-based simulation model estimates generation from installation characteristics, roof geometry, and meteorological data. The resulting production profile is combined with measured grid imports and exports to reconstruct household electricity demand. Dedicated indicators, including the self-consumption rate, self-sufficiency rate, and daytime consumption share, together with diagnostic visualizations, are then used to assess PV–load matching and identify opportunities to improve self-consumption.

After applying an unsupervised disaggregation correction based on grid import and export measurements, the PV simulation methodology achieves a MAE of 9.68 kWh/day, an RMSE of 12.49 kWh/day, an MBE of 7.84 kWh/day, and an nRMSE of 29.6%. These results are consistent with uncertainty levels reported in the literature for reanalysis-driven PV simulations and suggest that the dominant source of error originates from the ERA5/Open-Meteo meteorological inputs rather than from the pvlib performance model itself.

The BESS sizing module focuses on residential battery storage. A simulation and sizing framework is developed to evaluate the technical and economic benefits of storage for increasing local PV utilization. The model simulates battery operation at a 15-minute resolution while accounting for charging and discharging efficiencies, state-of-charge constraints, and realistic operating limits. Technical performance is evaluated through improvements in self-consumption and self-sufficiency, while an economic model estimates investment costs, annual savings, and payback periods. By comparing a range of battery capacities, the framework identifies the storage size providing the best compromise between energy performance and economic profitability for a given installation.

Overall, the developed modules transform DataWatt from a consumption-oriented analysis platform into a more comprehensive decision-support tool for prosumers, enabling improved understanding of PV performance, evaluation of self-consumption opportunities, and assessment of residential battery storage investments.