Batteries and flexible loads in a Local Energy Community: a Techno-Economic Approach

The energy landscape is evolving at record speed. The rise of renewable and thus flexible energy resources have led to the adoption of new energy market measures to enable a more decentral organisation of coping with network inbalances, in order to avoid huge inbalance costs at the central network operator-side. Recent market initiatives, such as Exchange of Energy blocks (Elia) and balancing based on real-time pricing, allow all kind of entities with flexible loads to participate in the energy market.

Next, the adoption of (1) solar panels, (2) smart meters, and (3) electrification of appliances, such as heating pumps and electrical cars, have urged organisations and individuals to evaluate the investment in batteries. Two ongoing developments have enabled the battery investment case, being (1) technological evolutions, and (2) energy legislation. First, despite the recent jump in silicon prices, battery technology has become more and more affordable in recent year. Driven by the surge in electric vehicles, as well as technological advancements, the cost per kWh dropped over the years, as shown in the graph from Bloomberg below. The upcoming capacity tariff (CAPTAR) and the abolition of the reverse counter are also measures that might render battery investments more attractive. However, the upfront investment remains high, and a mismatch between energy generation and consumption might persist.

For a Local Energy Community with central energy consumption and production infrastructure (solar panels, pumps, charge points for electrical vehicles, and a central battery), the question arises whether participating in the energy market by making available its flexible loads is to be preferred over the goal of complete self-sustainability by matching energy consumption, production and battery capacity (battery, vehicle-to-grid).

The student will gain the needed knowledge on recent market initiatives such as capacity tarrif, adjustable applications (Fluvius), Exchange of Energy blocks (Elia), Local Energy Communities (LECs) and how energy flows are organized. To that end, the student will digest relevant literature, interviews with the external supervisors and do desk research to gain the necessary background.

Second, the student will look into the energy consumption, production and storage in De Nieuwe Dokken, a Local Energy Community in Ghent. Modelling of the energy production and loads, combined with energy market data and products, will allow to build cost and revenue models for different scenarios, in order to determine cash flows for appraisal of each of the scenarios. Modelling of cash flows will require research to cost and revenue data, as well as assumption building (e.g. future amount of EVs in the Local Energy Community).

Finally, the evaluation of scenarios should lead to insights and recommendations. Results are completed using sensitivity analysis. If applicable, high investment uncertainty can be investigated with the use of Real Option Theory.