Microgrid energy storage 7 kWh

Electric microgrids are seen as a crucial global need to tackle the energy and environmental issues that our planet faces. The main reasons for this shift include the rapid increase in global energy demand, a growing focus on electric mobility, the declining condition of existing infrastructure, and the empowerment of consumers [1, 2].

Power dispatch in microgrids refers to the process of managing and distributing power generated by DERs within a microgrid. This can be a challenging task due to factors such as the intermittent nature of renewable energy sources and the need for coordination among multiple resources. Different control strategies can be used to efficiently allocate resources and optimize power dispatch within a microgrid [7, 8]. Economic dispatch of active power can also help minimize generation costs by taking advantage of cheaper renewable generators such as photovoltaic and wind turbines [8].

One approach to power dispatch in microgrids is through optimal power dispatching strategies that aim to minimize global energy costs, while considering forecasts for consumption and production as well as possible constraints imposed by the main grid operator [9]. Distributed control strategies can also be used to efficiently allocate resources and optimize power dispatch within a microgrid [10].

The economic dispatch system is responsible for the optimal calculation and active power setpoint commanding to controllable energy resources for each of the twenty-four hours of the following day"s dispatch (day-ahead dispatch). The complete architecture is developed through code in a Python multi-class environment.

The capture of initial system operational electrical measurements, the reading of necessary weather forecast conditions to calculate future states, and the dispatching of resulting control commands to manipulated resources within the corresponding period are integrated through code in the communication and operation logic of the program. The optimal power dispatch architecture for experimental implementation in microgrids and active distribution networks is presented in Fig. 1.

Now that the program environment has integrated the information of models, constraints, initial states, and forecast variables, the hourly optimization is executed to calculate the power setpoints for every DER of the microgrid, either based on cost or demand. The dispatch results for each device are written to the InfluxDB database for storage and further analysis. These commands are written to the database with the corresponding future timestamp for each of the twenty-four periods of the day.

In the next step, the optimal active power setpoints for generation resources and charging/discharging of storage devices are sent to the physical equipment in the microgrid via Modbus TCP/IP protocol during the corresponding period, aiming to generate the required power to fulfill the economic operational plan of the system for each hour. Similar to the database writing, the Modbus transmission of these setpoints is executed at the appropriate instant for each of the twenty-four dispatch periods.

Finally, after the twenty-four operating periods of the system have been dispatched, at 23:15, the control program restarts the connection with databases and automatically begins a new execution of the optimal dispatch architecture for the next day. Additionally, the code has been prepared to continue operating during most communication problems with devices and databases, so that execution continues for the available resources that can be controlled.

Having defined the integrated architecture for optimal power dispatch in the microgrid, the following section details the mathematical models and constraints for the diverse types of energy resources considered in the energy management system.

In this section, the mathematical models used to calculate the power generation and energy storage of DERs integrated to the optimal dispatch architecture are presented, including photovoltaic, biogas, and diesel generation models, and battery storage systems. These models are used to predict the behavior of different resources within the controlled microgrid and feed into the proposed dispatch algorithm.

The power generated by a photovoltaic module depends mainly on the solar irradiance received by the panel and the ambient temperature. Equation 1 is used as a general photovoltaic module power model, taking into account the available solar irradiance of the location, temperature corrections for the generated power, and lifetime degradation [31,32,33,34]. This classical model is adapted to depend on the solar radiation G(h) and ambient temperature (T_M(h)) for each time-period h of the next dispatched day.