Combined AI and Data solutions for creation of INSIGHTS

Challenge 2.3
Energy system Digital Twin decision support tool

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Challenge and Context: Grid operators for transmission and distribution increasingly face grid balancing challenges due to growing energy demand and decentralized renewable energy production. In addition, increased demand for integration of additional EV charging stations further complicates microgrid management and influences local grid stability. To balance power generation and demand, various energy storage technologies can be used. However, energy conversion and storage equipment incur capital and operational expenditures that affect the final price of electric energy. Optimal sizing of local renewable sources and energy storage is crucial for achieving an economically optimized energy system. Due to numerous variables, such as time profiles of energy consumption, energy generation, and dynamic pricing, and their nonlinear relationships, optimal solutions cannot be obtained analytically. This challenge seeks AI and Data solutions for a Digital Twin-based decision support tool to optimally size and control smaller parts (microgrids) of the energy system.

Use Case and Expected Solution: The expected solution should enable the grid operator to determine the most optimal local energy system (microgrids) sizing that will support EV mobility (inclusion of new EV charging stations) and its optimal mode of operation. The proposed sizing and operation solution should lead to a reduced cost for energy production, reduced energy storage system CAPEX, reduced wastage of renewable energy and possibility to integrate new EV charging stations without destabilizing the local grid. A Digital Twin (simulation model) structure for local energy systems is available at the partner's facility. Various prototype tools for manual and automated optimization have already been developed and tested at TRL 4. This low TRL level playground includes modules for energy consumption (including EV charging), generation (including local renewable sources), prices of electric energy from the grid, and energy storage systems (battery, electrolyser, fuel cell, hydrogen, pumped hydro). The provided Digital Twin enables simulation of the energy balance over a desired time period (typically an entire year) and observing economic results as a function of equipment sizes and prices. Another consortium partner is a grid operator providing a real-world microgrid playground with actual microgrid components and energy consumption/production measurements.

Specifications for Use Case: The low-TRL playground can be used by an SME to develop a Digital Twinbased decision support tool for optimal sizing of the microgrid components. The digital twin can also be used to experiment and test the microgrid control algorithms for different scenarios. The prepared solutions will be verified at the high-TRL playground with real-world data.

The selected third party is expected to contribute with the following:

- Develop an optimization algorithm for optimal sizing of a microgrid components using a microgrid Digital Twin
- Develop a microgrid grid energy control algorithms using predictions of energy needs and production
- Implement and test the developed solutions in a digital environment with real world data and for different scenarios

Key Performance Indicators:

Improved scaling of the energy storage components for the selected microgrid setup is envisioned to:

- Decrease CAPEX of energy storage systems (% reduction in CAPEX for energy storage),
- Improve local consumption of renewable energy (% increase in renewable energy self-consumption),
- Increase number of integrated EV charging stations while not affecting grid stability (% improvement in grid stability metrics).

To be noted, the list of KPIs provided in this section is not exhaustive but rather indicative. Additional KPIs will be studied and can be integrated to ensure quality outcomes.

Funded by the European Union