A Distributed Modular Co-simulation Platform for Local Energy Communities with Encapsulated Dynamics

Peer-to-Peer energy trading, energy sharing, self-optimization, or grid-supporting behavior are expected to become essential applications for energy communities and their participants. Due to the high complexity of physical and virtual energy flows, financial flows, and the optimization of controllable devices within a community, automated (digital) solutions are needed to handle these requirements.

Methodology

This project is about the simulation of a virtual environment (see figure below) that consists of various Docker containers representing the community participants (see Section “Community Setup”) as well as a mockup container for the Optimization Module. This container must be implemented according to the challenge constraints. Furthermore, price information is provided within the environment. The simulation environment is monitored by Prometheus (or alike), in each timestep (chosen within the range of 1 minute, 5 minutes, 10 minutes, 15 minutes).

Scenarios:

- Simulation of the docker environment for IEEE 14 bus and then subsequently of IEEE 118 bus system with a use-case:
- Simulation of a basic market clearance mechanism of a local energy community with objective to maximize the benefit of all Prosumers (energy consumers and producers)
- System wide constraints handling regarding voltage and line/transformer loading.
- Simulation of networking layer using any open-source communication system simulation to capture the artifacts of communication lag/noise/errors.
- Control of On-Load Tap changer and Off-Load tap changer for achieving system-wide objectives including that of distribution system operator.

End-outcome

A modular platform that enables simulation of a modern distribution system representing energy community that can further developed to test EV integration, virtual power plant and cyber security concerns.

1 Master’s degree thesis OR 1 BS thesis

Establishing the Platform for IEEE-14 bus system and making a script/engine that can automate creation of docker images, connect them using APIs and implement the monitoring and control nodes in the network.

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Multi-objective optimization to maximize the revenue for energy prosumers, distribution system operator by active dispatch of:

- Any distributed generator in the IEEE-14 bus system
- Dispatch of energy storage
- Dispatch of energy curtailment
- Control of tap changing of transformer

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