Extension of a Smart Grid Test Facility with Building Energy Agent Technology

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Background and Motivation

- **Background**: Existing Smart Grid lab infrastructure (two switchable 3-phase branches: emulated secondary substation with OLTC, emulated households and PV generation) is extended by a building automation agent.
- **Motivation**: Develop and test functionality of a “Building Energy Agent”
- **Problem**: Risky and expensive to test concepts in real grids
  - Hard to get a realistic test environment with simulator
- **Solution**: Extension of test facility “Intelligent Low Voltage Grid”
  - Emulate LV power grid (two 3-phase branches with ring option)
  - Emulate single hardware components like PV and EV
  - Extension by “Building Energy Agent” (BEA) rack representing a household and BEA functionality to be tested
- **New Use cases**:
  - Island mode – No external power supply
  - V2G/G2V – Integration of EVs into grid
  - Load shifting – Demand Side Management
  - Load reduction – Reduce grid load on critical external events

Infrastructure

- **Layer 1: Hardware**
  - Transformers STT800 for PV and local MV/LV transformers
  - Current sinks IS100 as variable loads for EVs and households
  - Smart Meters at critical measurement points in the grid
- **Layer 2: Software**
  - Central server for managing data exchange via “datapoints”
  - Clients as gateways, user interfaces, algorithms, profile generators
- **Layer 3: Model**
  - 3-phase LV power grid
  - Topology: (1) two branches, (2) one long branch or (3) closed ring
  - MV/LV grid transformer
  - two households with PV, two households without PV
  - Emulation of 24 h within 2 min by real hardware components

Integration of BEA in the Infrastructure

- **BEA functionalities**:
  - Maximize self-consumption of produced energy inside the building (e.g. from photovoltaic plants)
  - Generate accurate load and generation forecasts for grid operation and energy procurement optimization
  - Offer flexibilities (e.g. load shifting) for energy retailers, Virtual Power Plants (VPP) and grid operators
- **Connected devices and services**:
  - Smart Meter, E-Car charging station, photovoltaic inverter, building automation systems, external weather forecast provider
- **Information exchanged with infrastructure**:
  - The BEA receives P(U) and Q(U) characteristics in order to reduce consumption or generation in case of voltage band violations
  - Control signals from the building automation system are connected to the simulation system (see next section)