Panel on Microgrid Controller and Hardware in Loop (HIL) Testing

Moderators: Farid Katiraei & Russ Neal

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Each presentation as part of the microgrid controller and/or HIL testing panel will be limited to 5 minutes presentation.

Panelists are encouraged to use couple of slides to provide a brief overview of their platform (control approach and/or testing environment) and any distinctive design aspect and key functionalities.

After the short presentations/talks from everyone on the panel, we will primarily focus on questions from the audience or by the moderators.

Our industry recognized panelist are:

Microgrid controller:

Steve Drouilhet, Sustainable Power Systems, Inc.

Bobby Sagoo, GE Grid Solutions

Luis Zubieta, ARDA Power Inc.

Lorenzo Reyes Chamorro, Swiss Federal Institute of Technology of Lausanne (EPFL)

Microgrid controller HIL testing:

Jean Nikolas Paquin, Opal-RT

Onyi Nzimako, RTDS Inc.

Frank Kling, Etap

Paul Roege, Typhoon HIL

Below is a list of key topics (microgrid controller and testing questionnaire) for the Q&A session. Note that questions will be also shared with audience.

Microgrid controller questionnaire – short list:

1. Brief description of the **control platform** including:

    - How are various controls handled: any or all of primary controls (fast controls , millisecond time frame response), secondary or supervisory controls (second or sub second time frame, but not cycle), and tertiary controls (minutes or hour based time frame) for market participation or operation optimization

    - Centralized or distributed controls (distributed means the key control functions are implemented in multiple hardware devices in form of agents or autonomous controllers)

    - Main area of differences between the controller and conventional SCADA or DMS/EMS (distribution or energy management systems)

2. Main **hardware and software** associated with control system - covering end-to-end platform implementation, including:
    - interfaces to end-devices,
    - carrying computational processes associated with logic/rules, algorithm
    - interface with external engines with data exchange, such as customer-level load Data, weather data, generation forecast engines, data historian
    - interface with operator or markets
    - Trending and visualization

3. What are the **built-in functions, algorithms or processes** for supporting key operational aspects such as:
    - Functions for islanding transition (scheduled or unscheduled islanding)
    - Functions for re-synchronization with the main grid
    - Functions for dispatching resources
    - Functions for system stability during island mode
    - Functions in support of microgrid protection
    - Functions for extending the island duration: example, in response to n-2 contingency

4. **Communication architecture and protocols** supported: for data/command exchange among components of the control platform, from controllers to end devices (DERs , relays), and from controllers to the databases, and computational engines

5. **Programming capability** and possibility of making modifications in the logic / operation constraints by the user without the need to go back to vendor.

General questions:

1. Would be any difference in the design / components of your Microgrid control system for seamless transition versus break before make Island formation. Please explain!

2. Is there any provisions in the control system design or the features for hardware in loop testing?

Hardware in Loop testing of Microgrid control system – short list of questions:

We would like the HIL testing panelists make their case that why their HIL approach is the most suitable for Microgrid control system testing. Please also address the following question and/or be prepared for responding to audience on these questions.

1. Brief description of the **HIL test platform** including:
    - Software and Simulation environment
    - Electrical modeling or Mechanical and Thermo-dynamic models also
    - Time step of analysis (minimum & maximum)
    - Methods of communicating / data exchange with Real World environment (hardware under test and closing the loop)
        - Input and output interface ports or cards (analog, digital, comm, etc)
        - Reading data or saving results in: text, CSV, ComTrade, PQdiff, or other formats

2. **Limitation in modeling** any type, size or functionality of the components or events that need to be tested:
    - Power system component models
    - Control system component models
    - Thermal components (e.g. combined heat and power or cooling systems)
    - Size of the system
    - Creating events: short circuit faults, disturbances (voltage / frequency deviations), harmonic injection, equipment failure, others …

3. How **time step is coordinated** between the simulation environment (model) and the real world environment for time-sensitive events – such as control/protection close loop response?
    - What is the source of internal time clock?
    - Is there a GPS card or function?
    - What are the time-stamping methods: 1 PPS, IEEE 1588, others?

4. What type of industrial **communication protocols** are supported?
    - CANbus
    - Modbus,
    - DNP3,
    - IEC 61850 GOOSE and MMS
    - IEEE C37.118
    - OpenADR
    - OpenFMB
    - Others ?

5. What is the **method of automating the test** runs?
    - 100s of fault cases
    - 100s of power quality cases
    - 100s of loading conditions
    - Second contingency cases

6. Does your HIL environment provide **specific models** for:
    - Voltage and Frequency (or fault) Ride Through Curves
    - Differential protection relays and communication assisted relays (with permissive schemes)
    - Generation Dispatch (day-ahead or hour-ahead)
    - Automatic Generation Control (AGC)
    - Generation optimizer (renewable versus fossil fuel type)
    - Fuel consumption tracker
    - Energy efficiency tracker
    - Reliability and resiliency tracker