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RTDS PLATFORM FOR HIL TESTING OF ENERGY MANAGEMENT SYSTEMS

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2023 North American RTDS TECHNOLOGIES INC. APPLICATIONS & TECHNOLOGY CONFERENCE

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Shell's net carbon intensity

Also, in this presentation we may refer to Shell's "Net Carbon Intensity", which include Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Intensity" is for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Intensity (NCI) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCI target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward Looking Non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as cash capital expenditure and divestments. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this presentation do not form part of this presentation.

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PRESENTATION OUTLINE

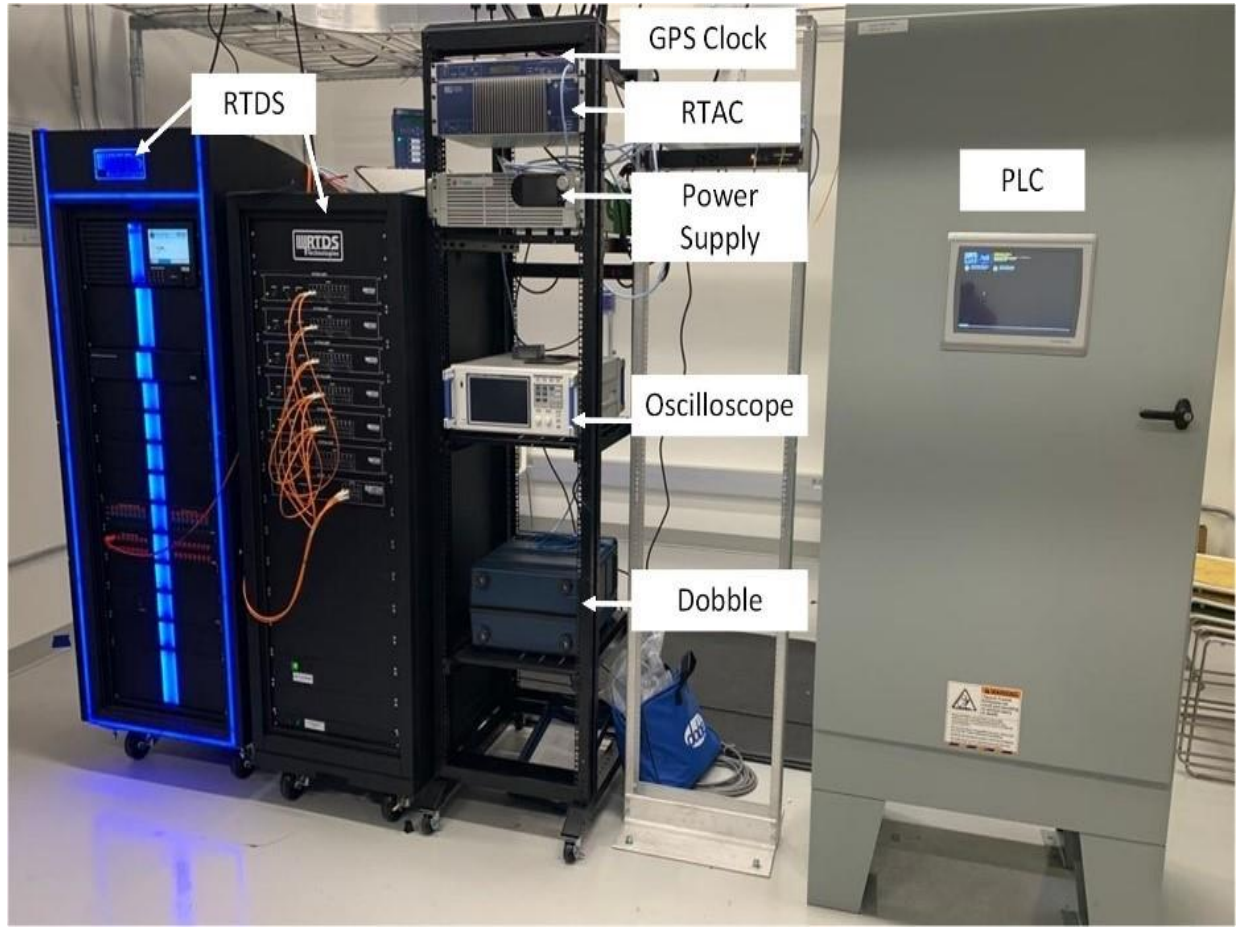
- Overview of the microgrid testbed at Shell Technology Center Houston (STCH).
- Development of an RTDS platform at STCH for HIL testing of Energy Management Systems (EMS).
- Creating a simulated version of the EMS logic to verify the RTDS model before HIL testing with EMS.

SHELL STCH MICROGRID TEST FACILITY

- Battery energy storage system capable of grid forming (260kW/1050kWh)
- Natural gas genset capable of grid forming (127kW)
- PV system (300kW)
- Switchgear for two microgrid points of interconnections
- A facility building load
- Load bank (250kVA)

RTDS LAB AT STCH

- RTDS Simulator
- SEL GPS Clock
- Energy Management System implemented in Allen Bradley PLC
- SEL Real Time Automation Controller (RTAC)
- Protective Relays
- Amplifiers



EMS HIL TESTING USE CASES & CONTROL FUNCTIONS

- Control-HIL testing of Energy Management Systems before implementation in the field.
  - Load following
  - Peak shaving
  - Export control
  - Islanding
    - Planned and unplanned islanding
    - Islanding through each of the two points of interconnection
  - Resynchronization & Grid reconnection

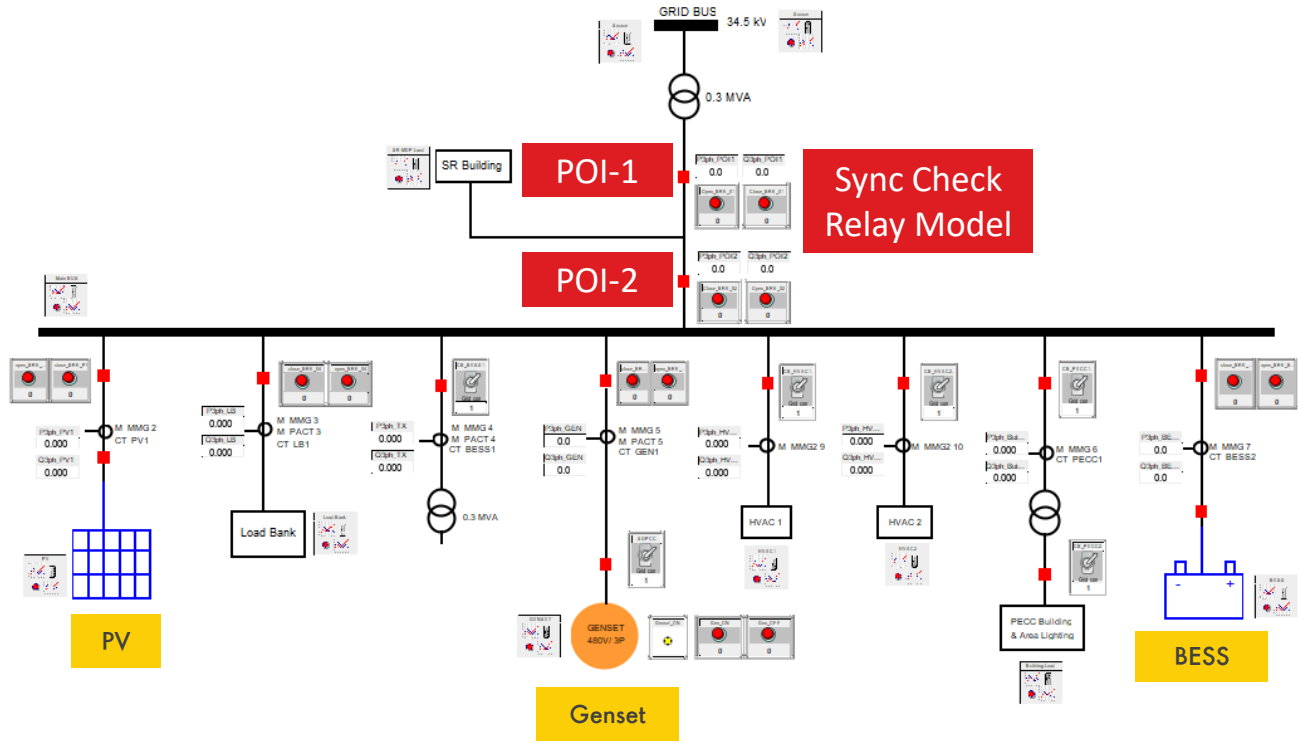
EMS HIL TESTING USE CASES (CONT.)

- Validation of complex EMS logics for controlling different microgrid assets to achieve various energy management, cost saving, emission reduction, and system stability objectives.
- Validation of EMS against some of the extreme scenarios and corner cases which are not tested before due to difficulty in testing with real microgrid assets.
- Testing of cloud-based solutions

STCH MICROGRID POWER SYSTEM MODEL

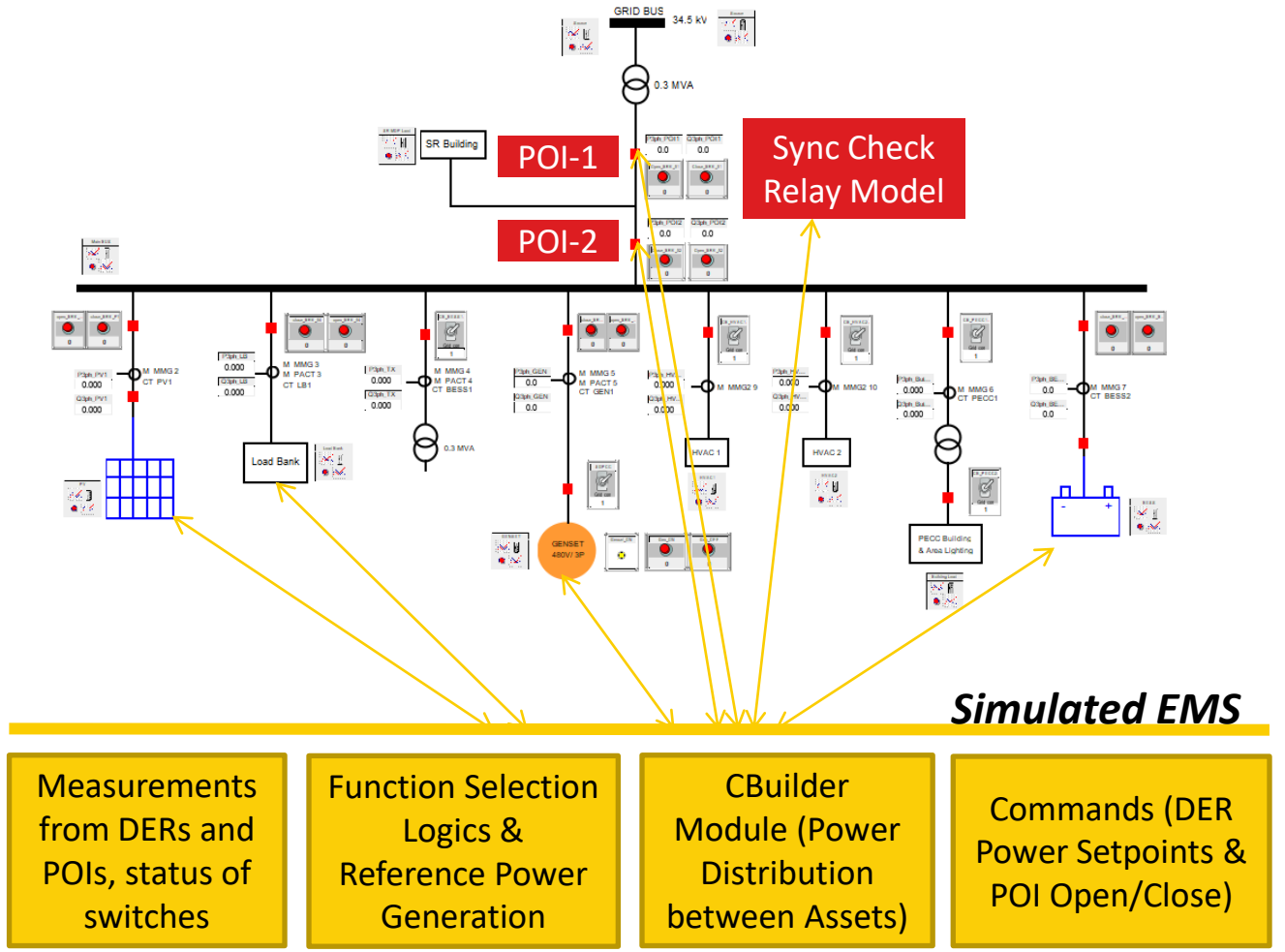
Power system model of the STCH microgrid test facility in RTDS includes:

- Battery energy storage system
- Generator
- PV system
- Microgrid POI switches
- POI protective relay and sync check relay
- Facility loads and load bank



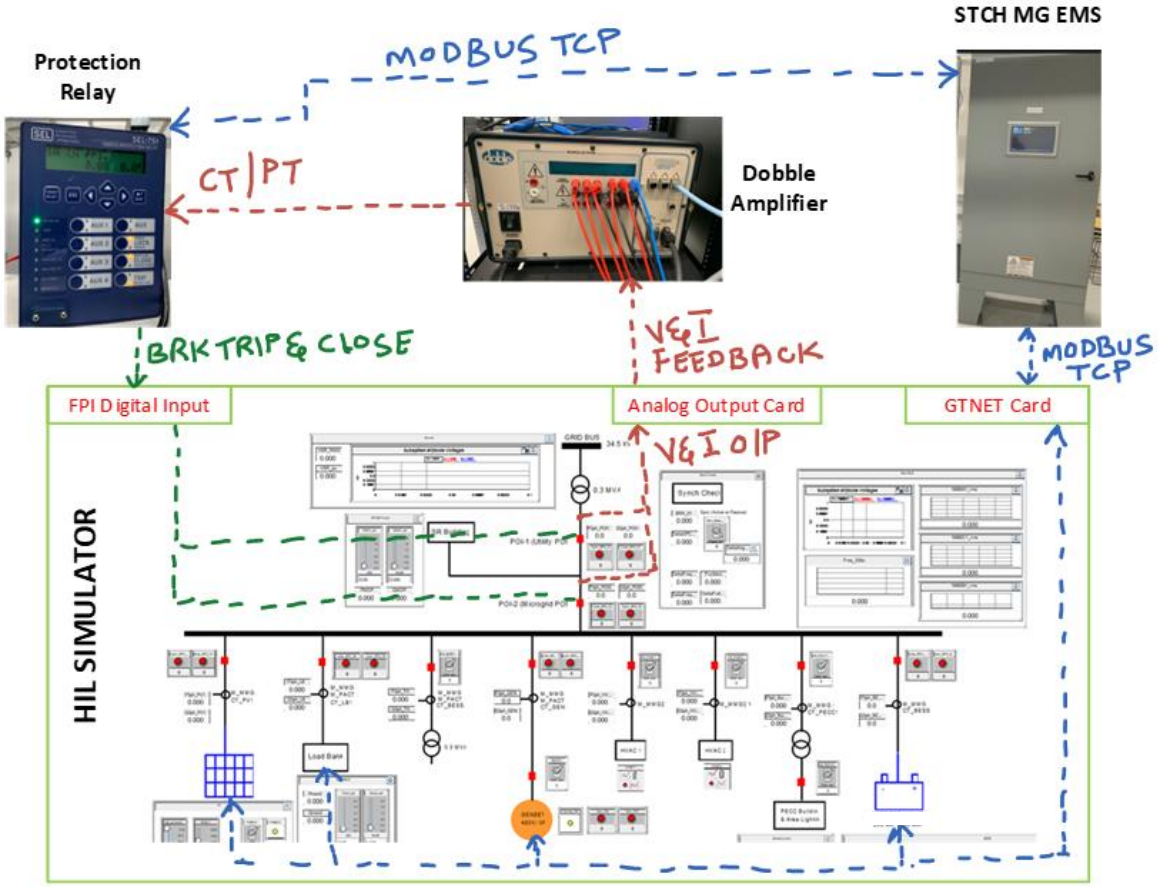
DEVELOPMENT OF SIMULATED EMS IN RTDS

- Implementing the EMS functions.
- For grid connected functions:
  - Selection between BESS or Genset as the leading resource (when the leading resource reaches 80% capacity, then other resource is brought online)
- For islanding function:
  - Selection between POI-1 or POI-2 as the islanding point.
  - Selection between BESS or Genset as the grid forming resource.



EMS HIL TESTBED DEVELOPMENT

- The microgrid assets are controlled by an external EMS over physical MODUS TCP link
- STCH MG EMS is the controller under evaluation and can be tested for its control modes by running the microgrid simulated in RTDS through various operating scenarios.
- External protection relay is also shown providing protection functions for the microgrid. This allows testing of the protection relay as well before the actual deployment.



EMS HIL TESTBED DEVELOPMENT FOR CLOUD-BASED CONTROL