Overview of Distribution Network Simulator at EMS Shinjuku R&D Center
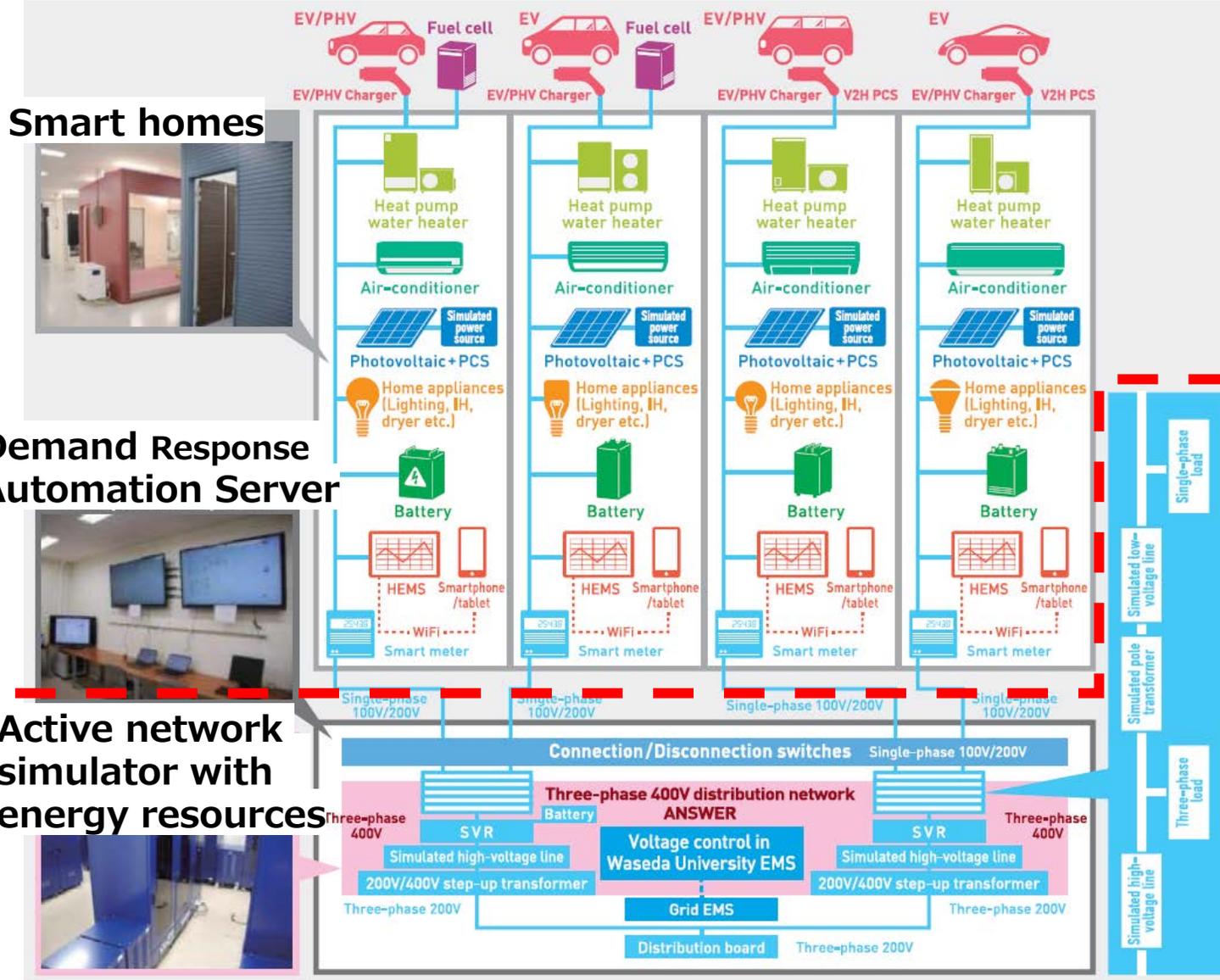
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5th Annual International Workshop on
Grid Simulator Testing of Energy Systems and Wind Turbine Powertrains
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FSU Center for Advanced Power Systems

- Smart homes equipped with smart meters and appliances with communication function

- Demand Response Automated Servers (DRAS)

- Distribution Network

Smart homes

Demand Response Automation Server
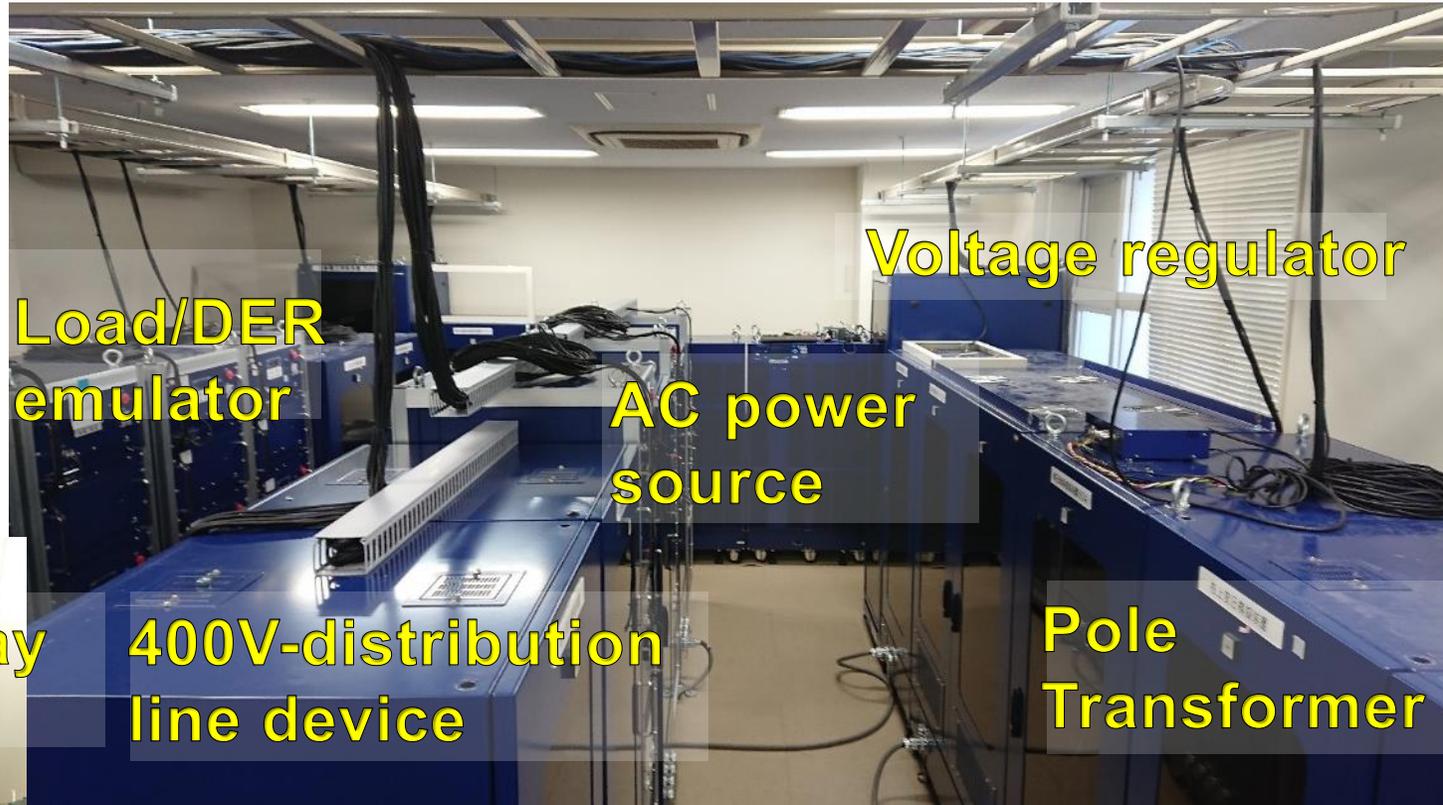
Active network simulator with energy resources

Distribution Network Simulator: ANSWER

- Scale down in a laboratory environment (54kVA, 400V, 60A)
- Designed to emulate various distribution system conditions

Smart Inverters

Load/DER emulator

Voltage regulator

AC power source

Triphase Power Module

Solar Array Simulator

400V-distribution line device

Pole Transformer

100V-distribution line device

Distribution Network Simulator: ANSWER

Distribution Network Simulator

✓ 100/200/400V nominal voltage levels

✓ 54kVA capacity, Max.60A current

Smart Inverters

✓ 3-5kVA capacity inverters

✓ 1.25kVA micro-inverter

✓ CA Rule21 functionalities are implemented
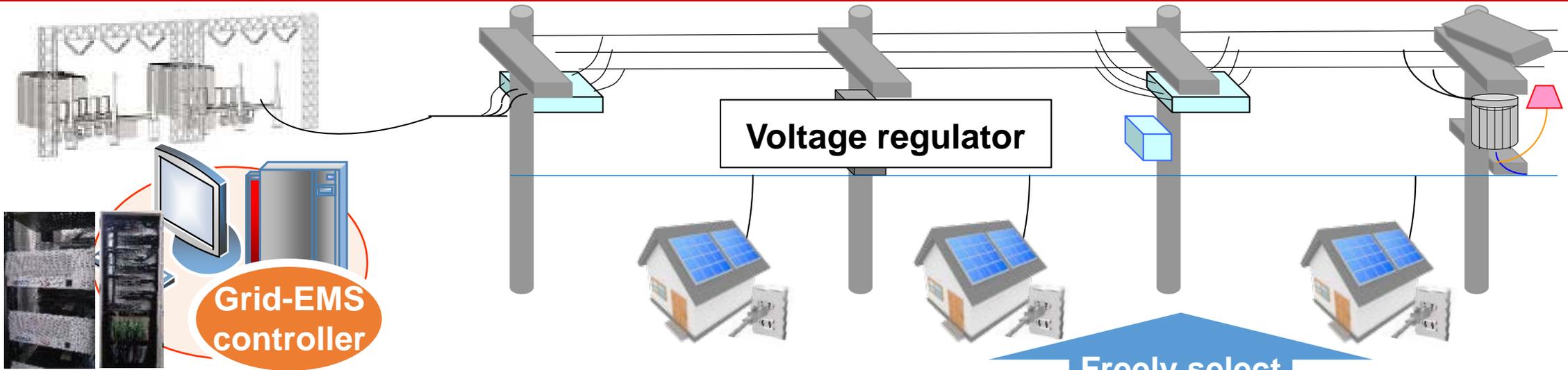

Real-time simulator (dSPACE/RT-LAB)

✓ Voltage regulation of tap changers, batteries, and reactive power devices

✓ Measurement (voltage, current, power factor, phase, frequency, etc.)

DERMS:

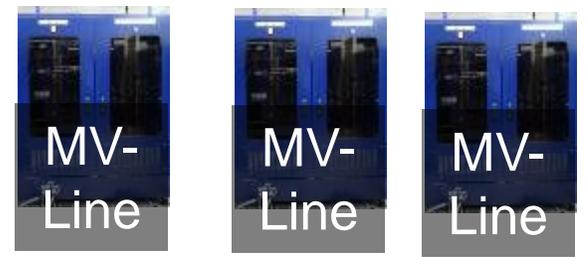✓ Parameters settings and monitoring for smart inverters and ANSWER status

Voltage regulator

Grid-EMS controller

Freely select and connect

ANSWER components

OLTC | SVR

LVR | LVR

Voltage regulators

MV-Line | MV-Line | MV-Line

LV-Line | LV-Line

Load/DER | Load/DER

Load/DER | Load/DER

OLTC

Grid-EMS controller

MV-Line

Volt SVR egulator

MV-Line

MV-Line

LV-Line

Load/DER

Load/DER

Load/DER

LVR

Implementation

Measurement

Grid-EMS methodology

Visualization

Activation

Optimization

Evaluation and Improvement of developed EMS
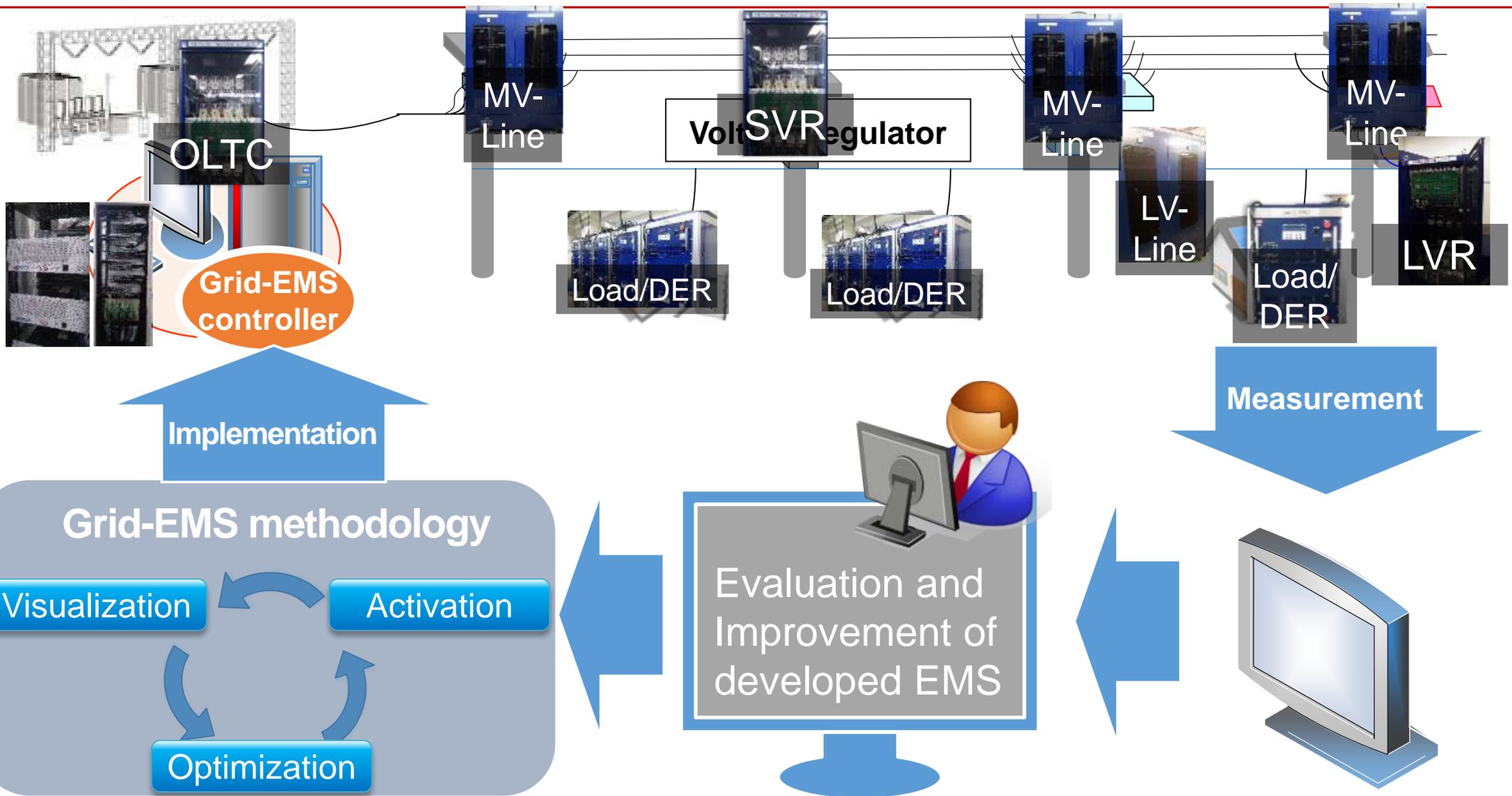
- Five smart inverters are installed and connected to distribution system simulator ANSWER and DERMS.

OpenADR2.0b for SI

Sunspec Modbus

Echonet Lite

All-in-one

DERMS

Comm. terminal — SI #1

Comm. terminal — SI #2

Comm. terminal — SI #3

Comm. terminal — SI #4

Comm. terminal — SI #5

HEMS

HEMS

Distribution system simulator

ANSWER

DERMS: Monitoring DER Status

ANSWER measurement (Voltage, Current, Voltage regulator status)

Monitoring DER status and output

SI #1

SI #2

SI #3

SI #4

SI #5

tepco-sinv-0004

Frequency

Measurements

Active power

Voltage and current

Reactive power
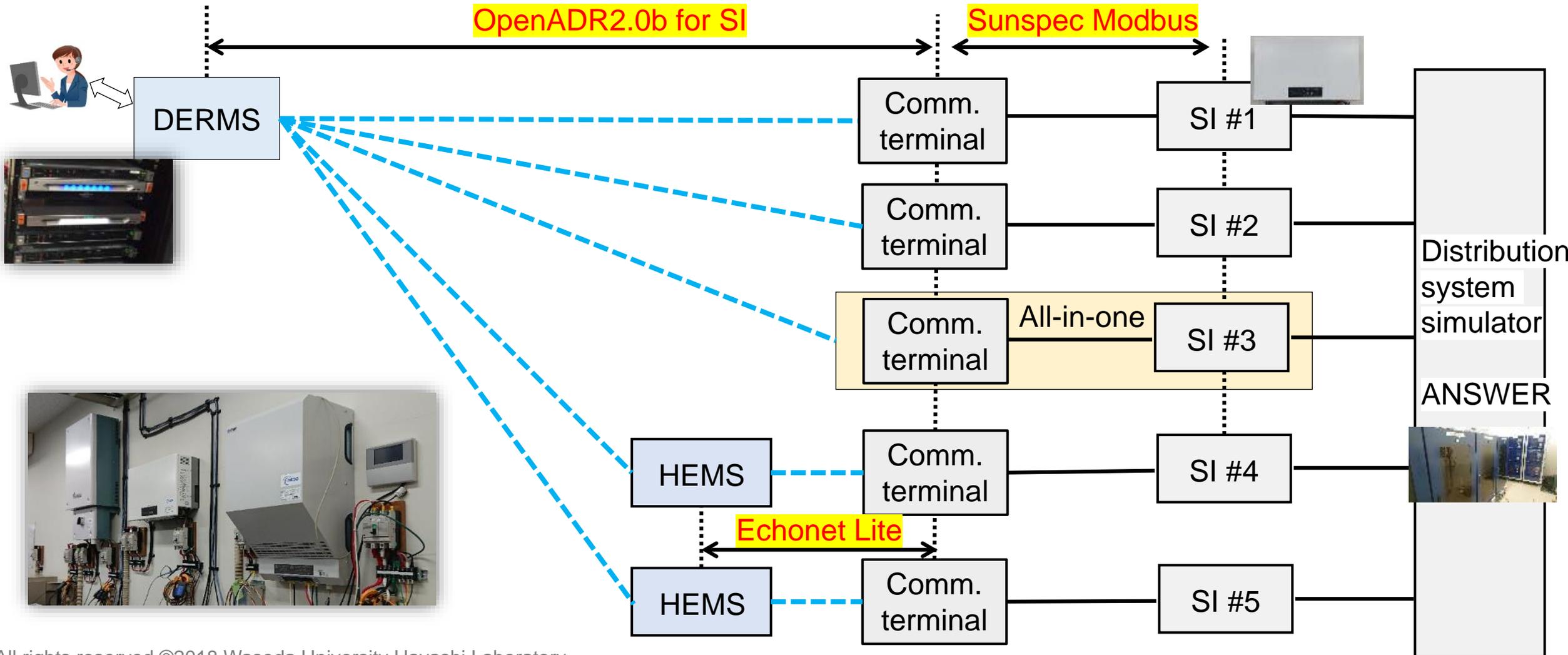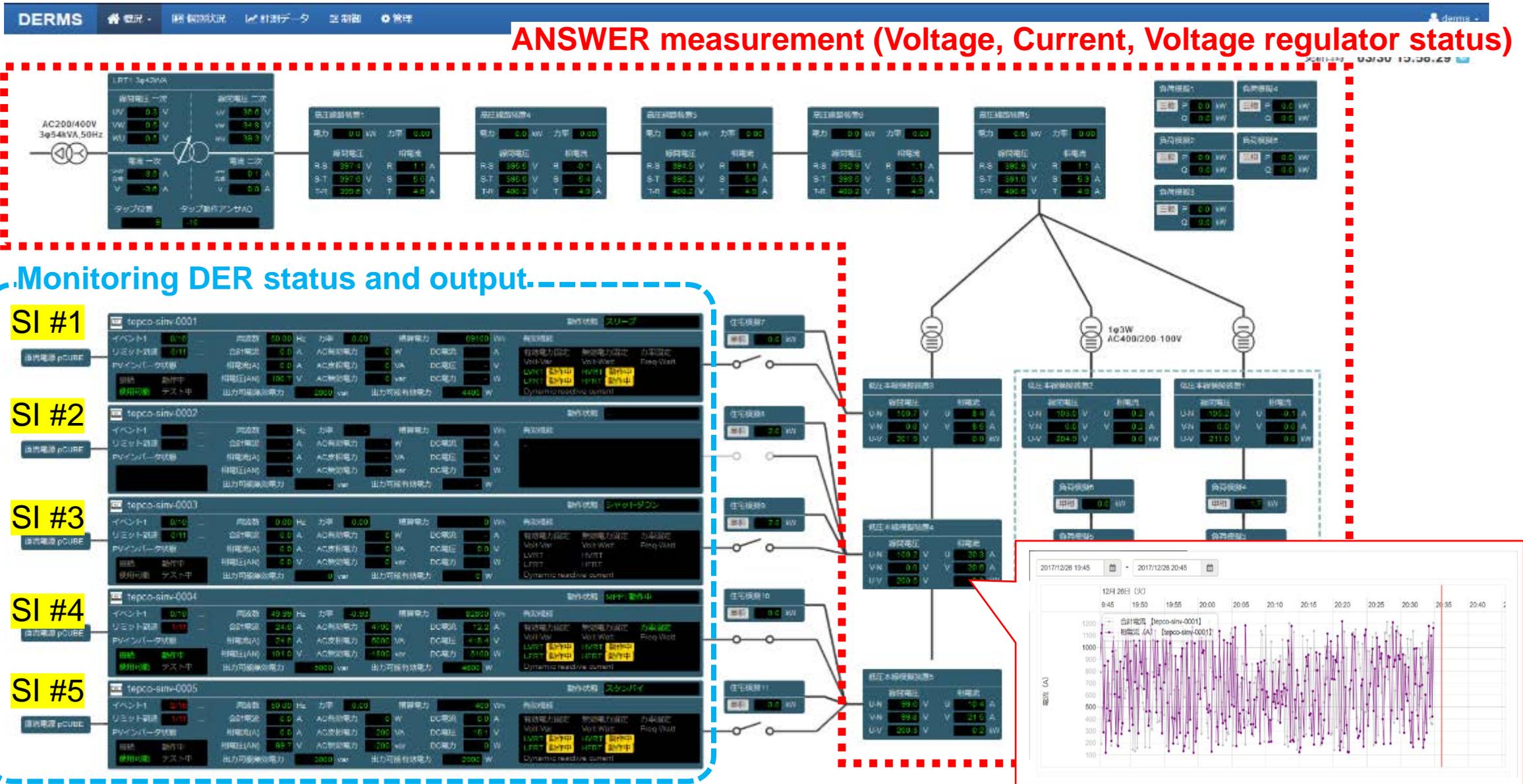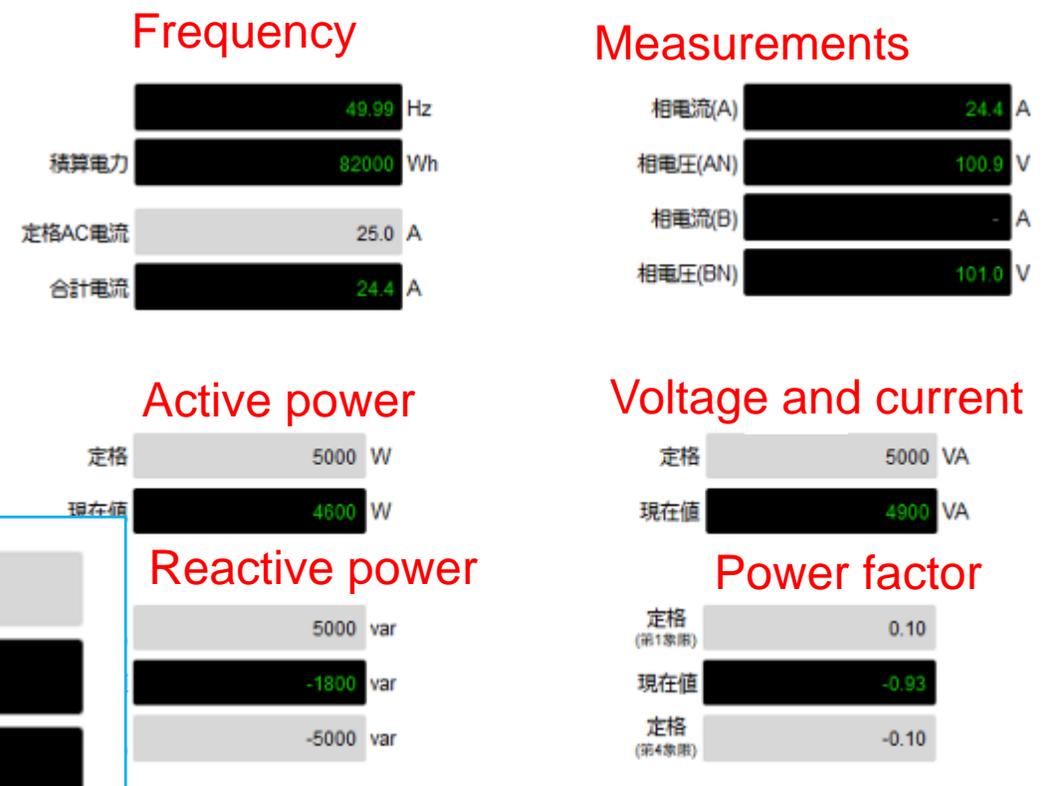
Power factor

DER status and enabled functions

Connect

Fixed power factor

Ride-through function

- Built a simple distribution system and tested LVRT function under several conditions

Distribution substation

AC200/400V
3φ54kVA, 50Hz

Voltage Sag Profile（RT-LAB）

MV-Load
3ph-8kW

MV-Load
3ph-8kW

MV-Line   MV-Line   MV-Line

Monitoring and operation

dSPACE/RT-LAB

ANSWER settings
Solar irradiance

DERMS

Smart inverter setting
Update parameters
Monitoring DER status

1φ3W
AC400/200-100V

LV-Line

Smart Inverter   LV-Load

PV array

0.5 pu
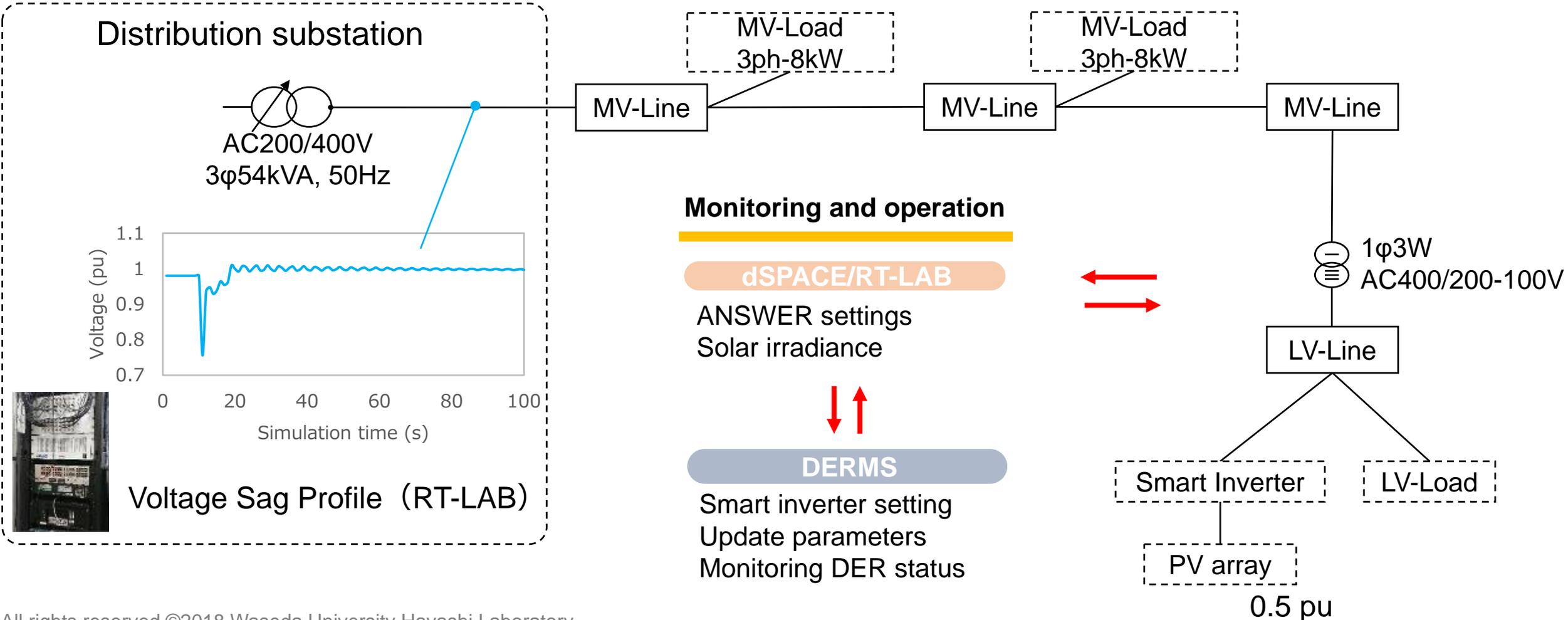
Low Voltage Ride-Through Testing: Parameters Setting

- LVRT refers only to the connect/disconnect behavior of the DER, essentially defining the voltage conditions under which the DER may and must connect and disconnect.

Low Voltage Ride-Through Testing: Results

30% of Voltage Sag

70% of Voltage Sag

Remain connected

Disconnected
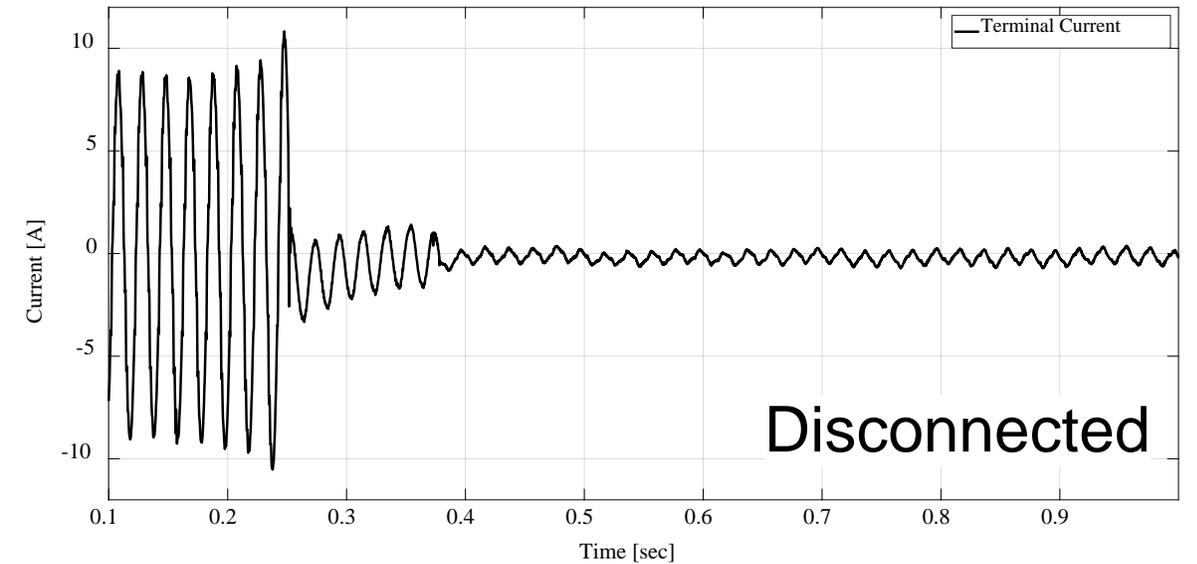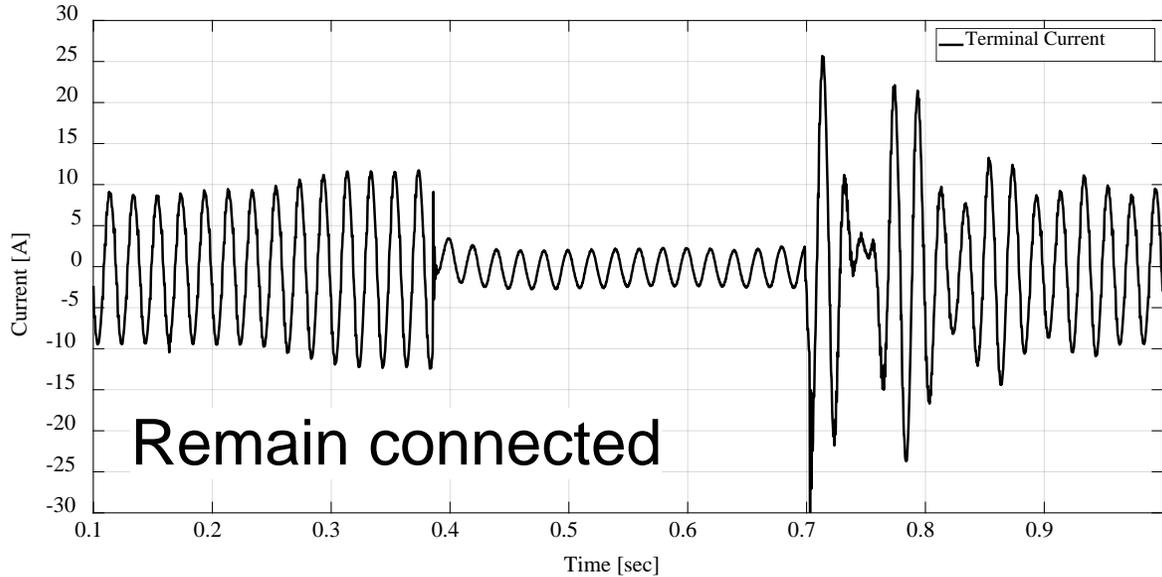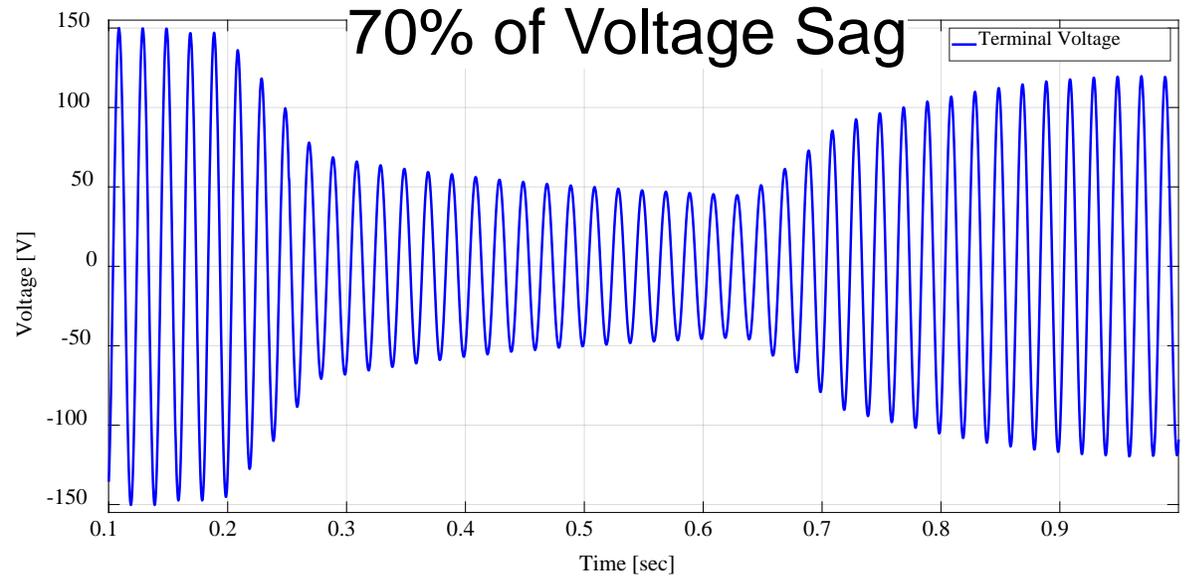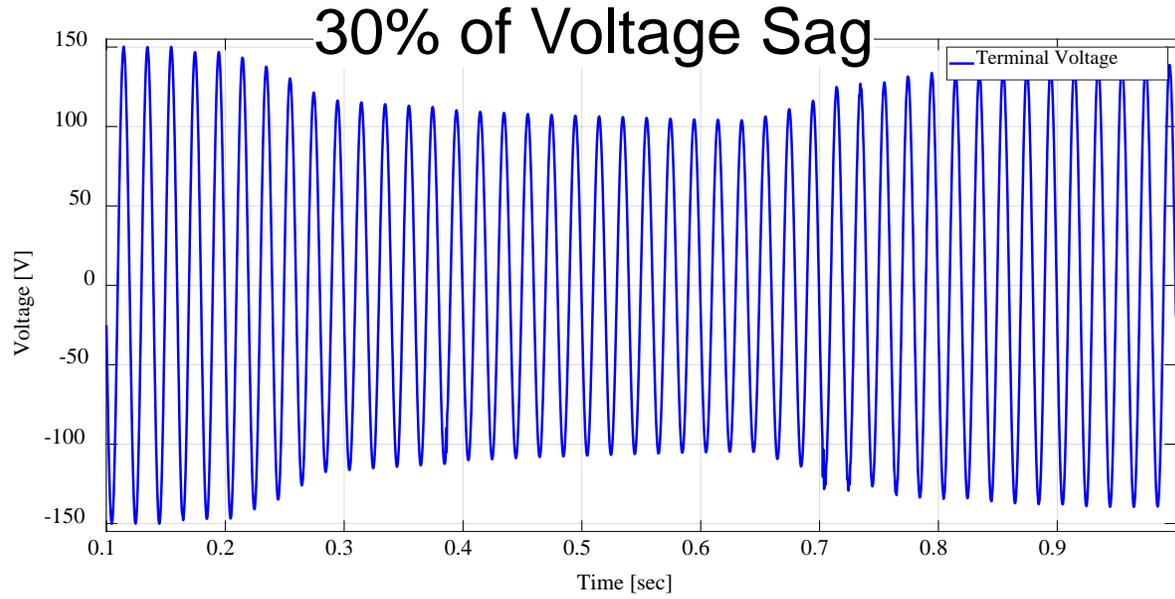
Thank you for your attention
Any Questions?

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