OBJECTIVE AND SIGNIFICANCE: With funding from the U.S. Office of Naval Research (ONR) under the Asia-Pacific Regional Energy Systems Assessment (APRESA) grant, HNEI's Grid System Technologies Advanced Research Team (Grid*START*) developed a capacity building program focused on renewable energy integration and smart grid technologies development and application for engineers from the Provincial Electricity Authority (PEA) of Thailand, the Thai distribution grid operator responsible for electricity supply to the entirety of Thailand, except for the Bangkok metropolis and two adjoining provinces.

BACKGROUND: Initiated in Spring 2020, the internship program was designed to accept two classes of six PEA engineers annually, participating in an eight-week curriculum of combined lectures (40 hours) and team oriented deep emersion in custom "mini-project" research, development, and test endeavors tailored to the learning needs of working utility engineers. A renewable energy integration and smart grid technologies series of lectures with emphasis on energy distribution system applications was developed and delivered to the PEA engineers. The first PEA class of interns was received at HNEI from March to May 2020. However, due to COVID-19 travel restrictions, the second intern class was postponed and bifurcated into: (1) a five-day online lecture component conducted remotely in May 2021; and (2) an in-person lecture component from October to December 2021, which is currently being conducted at HNEI.
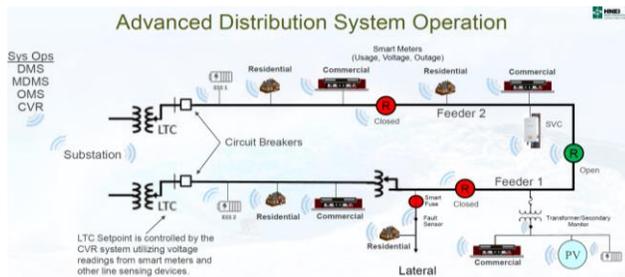

Figure 1. Sample of the teaching materials.

The training leverages the planned installation of several HNEI-developed distributed power monitoring/control units (Advanced Real-Time Grid Energy Monitoring System, or "ARGEMS") on select service transformers in PEA's service territory. The training includes mini-projects developing new sensing and controls applications residing on field-deployed ARGEMS units and bidirectional electric vehicle (EV) chargers installed by HNEI on the UH Mānoa campus.

PROJECT STATUS/RESULTS: The online component for the PEA internship in 2021 provided six PEA engineers with technical learning on topics, such as distributed energy resources (DER) technologies and microgrids. For the in-person component, the class was split into two groups, each focused on one of two mini-project topics: (1) ARGEMS application development: Distribution Secondary Fault Detection and Location; and (2) Bidirectional EV Charging Control Optimization.

In the ARGEMS mini-project, the PEA engineers engage in research to develop a sensor to detect and locate faults on primary radial distribution feeders. Specifically, this project aims to: (a) develop a fault detection and location algorithm for distribution systems using low voltage secondary service lines sensing; (b) test, calibrate, and validate the fault detection and location algorithm using available field data, lab tests, and/or simulations; and (c) integrate the developed algorithm into ARGEMS.

Figure 2. HNEI Grid*START* patented ARGEMS devices.

In the EV Charging mini-project, the PEA engineers engage in research to develop new algorithms to optimize the charge/discharge of shared electric fleet vehicles. The objectives of this mini-project include: (a) determination of the most appropriate objective functions, constraints, and optimization solvers to expand and generalize the charge/discharge management to address larger pools of heterogeneous EVs; (b) implementation and integration of the selected algorithm into the EVs' charging control systems; and (c) testing, calibration, and validation of optimization problems using available field data, lab tests, and/or simulations.

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