Task 2. Overview: *This is not the full task problem statement. The complete document will be published when all parameters are approved by our industry and government partners. Items in question are noted in italics in the document.*

Hydrogen-based DERMS Grid-tied Technologies

Task sponsored by Diamond Sponsor El Paso Electric Company
and Gold Sponsor Las Cruces Utilities

Task:
Teams will design hydrogen-based technologies in combination with intermittent renewable energy technologies such as photovoltaics to demonstrate how intermittent renewable energies can be modified to become a firm dispatchable resource.

Background
As more renewable and emergent technologies, such as rooftop solar, Battery Energy Storage Systems (BESS), and Electric Vehicle (EV) adoption continue to grow in our region, we are looking for ways to integrate these Distributed Energy Resources (DER) into the electrical grid to support grid resilience and ensure the grid's ability to withstand and/or recover from disruptive events.

New technologies, such as Hydrogen-based technologies, allow grid operators to provide more advanced levels of control, and allow private operators to provide valuable services to the grid.

DER consists of two subsets: 1) Power generation sources (solar, wind, nuclear, fuel cells, generators powered by internal combustion engines) and 2) stored energy sources of power (Fuel cells, EVs, BESS). Renewable DER, such as solar and wind, are intermittent energy sources for which the energy production peaks do not always match energy demand. This increased variability can be costly and create potential disruptions to the modern grid's operations. To solve the issue, companies implement advanced digital solutions for leveling loads on the grid, such as Distributed Energy Resource Management Systems (DERMS).

<u>Grid Basics</u>
On the supply side, utility companies need to provide reliable energy. To do so, they predict the maximum demand required when loads are expected to reach a peak, such as during extreme weather events (very hot summer days or winter storms), and they design their power generation and Transmission and Distribution (T&D) systems to match the demand expected from peak loads. Their designs must strike a balance between supply and demand to ensure supply systems are not underbuilt, which may result in outages, and are not overbuilt. Overbuilding needlessly raises the cost of electricity for all rate payers.

Task 2. Advancing DERMS Technologies

There are often times when supply and demand do not match. The primary events are:

Peak Load Events: During extreme events, customers use more energy than usual to heat/cool their buildings. This can exhaust the energy that the utility company is able to supply. Such peak load events place stress on the grid and may lead to brownouts or blackouts.

Low-Carbon Energy Events: Conversely, during off-peak daytime hours, the amount of solar, wind, or other low-carbon distributed energy sources may far exceed demand. Referred to as a "low-carbon event," this excess energy places a strain on the grid, often requiring a utility to pay neighboring utilities to take the excess energy off of their hands; such "negative pricing" raises costs for the utility company and its rate payers.

<u>Supporting the Grid</u>

A solution is needed that will level the generation profile (known as "firming") by storing energy during low-carbon events and making it available during peak load events. As generation is firmed across a day, there is an added advantage of leveling market prices for electricity, helping reduce costs for consumers. In addition, efficiently storing renewable energy can reduce a community's carbon footprint.

DERMS have the ability to shed, shift, modulate, or generate electricity [1]. Examples for each of these are: dimming lights during peak loads will *shed* the load, EV charging can be *shifted* to off-peak times, or stored energy in EVs can provide energy back (*shifting*) to a building or the grid, batteries *modulate* power to maintain the grid, and rooftop solar *generates* electricity.

Firming on the grid scale is a way to level generation by de-coupling energy production from energy consumption. It has been implemented using Battery Energy Storage Systems (BESS) to store excess energy by charging the batteries during low-carbon events (times of excess renewable energy on the grid) and later utilizing that energy when energy demand is high. The goal of firming is to ensure a constant output from an intermittent energy source for a specified period of time. Firm energy output is equivalent to a flat electricity output curve.

A schematic for combining a photovoltaic plant (PV) combined with battery storage for a utility operation in New Mexico is shown in Figure 1. The goal is to store excess energy from renewables to achieve firm (reliable) energy output at a later time. The stored energy from PV output (the area under the green curve) can be used to provide firm energy output in the morning and evening (blue shaded rectangles). The goal is a perfectly level stored-energy curve. This would indicate a "firm dispatchable resource'" meaning that the energy available meets specified criteria and will be reliably available to be dispatched to the grid when needed.

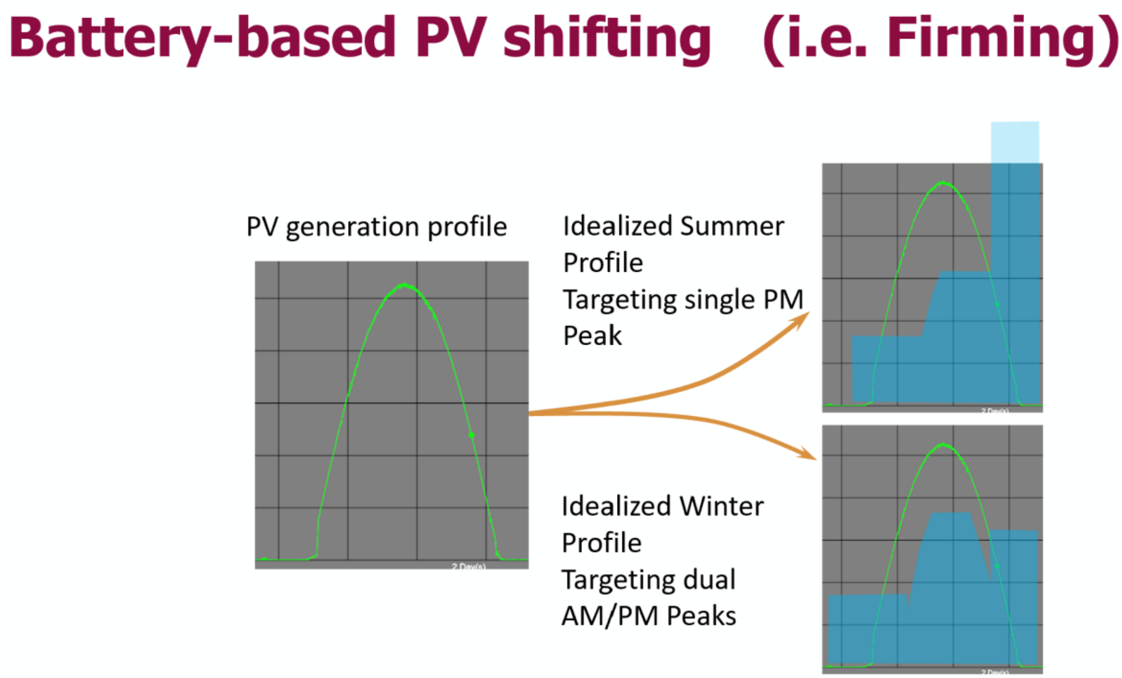

Figure 1. Combining PV plan with battery storage with idealized PV generation.

Figure 2 shows the results of a real-life BESS implementation at a utility operation in New Mexico. As is seen in the figure, perfectly flat stored energy curves are rare in application. Therefore, the variability (or DC ripple) is measured to assess the firmness of the energy resource.

Some challenges with working with variable PV are the rapid changes in loads that create "ramps" in the curves. These require special algorithms for responding to this variability and efforts to create a firm resource that is as firm (i.e., as flat) as possible. The real-life curves in Figure 2 illustrate that this is a difficult and complex challenge.

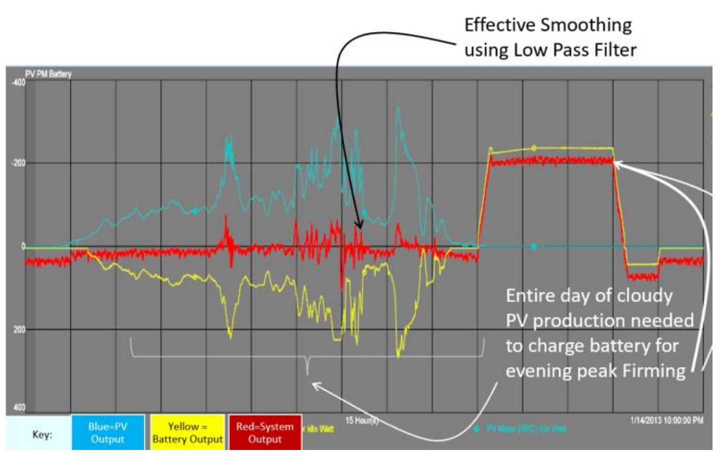

Figure 2. Real-life curves illustrating combining PV plant with battery storage for a utility operation in New Mexico.

Integrating Hydrogen

The innovation requested in this task is to utilize hydrogen-based technologies to modify intermittent renewable energies into firm dispatchable resources.

For this competition, teams will be challenged to use a Fuel Cell plus appropriate medium (water, hydrogen) INSTEAD of battery storage. Additionally, teams will be challenged to design and implement ant additional circuits and/or algorithms to make the energy output from a combination of PV+Fuel Cell as “flat” as possible, similar to the illustration on figures 1 and 2.

Problem statement

Design and develop a DERMS grid-tied solution that integrates an intermittent renewable PV source with a hydrogen fuel cell to provide a firm dispatchable resource.

Design algorithms for responding to PV system variability and making the firm resource as firm as possible. Pay special attention to the ramp rates of the PV system. System performance will be measured by measuring the output characteristics of the firm dispatchable resource, specifically DC ripple or variability.

Design requirements

Details coming Soon – Watch for full problem statement.

Bench-Scale Demonstration

Coming Soon – Watch for full problem statement.

Pre-contest Bench-scale Testing

Teams should pre-test their equipment at their home location power systems laboratory or similar.

Analytical Testing at the Contest

Teams will connect to WERC’s infrastructure and demonstrate their system’s functionality.

At the contest, each team will be provided with testing infrastructure consisting of:

- TBA

Teams are expected to bring to the contest:

- All necessary software and hardware control infrastructure needed for demonstration of up to five electrical connections.
- *Additional information TBA*

Experimental Safety Plan (ESP)

Submit your plans for the bench-scale demonstration in your team’s ESP. See team manual for details.

Task 2. Advancing DERMS Technologies

Required Safety Short Courses

- The course, "Preparing the Experimental Safety Plan" is required of every member of your team. You will be emailed a link to access the ESP short course after your team registers for the contest. Complete this training on or before February 20, 2025.
- The "Hydrogen Safety Awareness" course is required of all team members participating in Task 2 prior to submitting the ESP.

Evaluation Criteria

Each team is advised to read "Evaluation Criteria" and "Contest Scoring" in the 2025 Team Manual for a comprehensive understanding of the contest evaluation criteria. For a copy of the Team Manual, Public Involvement Plan, and other important resources, visit the WERC website: Guidelines | werc.nmsu.edu

In addition to evaluation criteria that applies to every task, judges will evaluate your team's response to the problem statement, with consideration of the Design Considerations listed above.

Dates, Deadlines, FAQs (*dates subject to change—watch website FAQs*)

- Today: Email us to let us know you are interested in this task. We will contact you with breaking news.
- October 15, 2024 - December 31, 2024 – Early Bird Registration (discount applies).
- December 1, 2024 - February 20, 2025: Mandatory On-demand Course: Preparing the Experimental Safety Plan. See website and Team Manual for information.
- February 17 - 26, 2025: Experimental Safety Plan (ESP) due. Include requests for volume of brine concentrate and ancillary equipment needed at the contest.
- March 7, 2025: Final date to register a team.
- March 31, 2025: Technical Report due
- Weekly: Check FAQs weekly for updates:
  - Task-specific FAQs: 2025 Tasks/Task FAQs
  - General FAQs: 2025 General FAQs
- All dates or task requirements are subject to change. Check FAQs for updates online.

Reference

[1] Lavrova, O. and D. Zigich. July 6, 2021: Non-Wires Grid Alternatives: Behind-The-Meter. Whitepaper submitted to New Mexico Energy Manufacturing. (Available upon request; email: werc@nmsu.edu)

Glossary of Abbreviations

API – Application Program Interface
BESS – Battery Energy Storage System
DER – Distributed Energy Resources
DERMS – Distributed Energy Resource Management Systems
EPE – El Paso Electric
EV – Electric Vehicle
LCU – Las Cruces Utilities
SoC – State of Charge
T&D – Transmission and Distribution
V2G – Vehicle-to-grid