



NATIONAL
LABORATORY
OF THE ROCKIES

Advanced Distribution Grid Controls Test Bed Overview

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ESIG Spring Workshop, Tuscon, AZ

NLR's Advanced Distribution Grid Controls Test Bed

The test bed evaluates commercial and pre-commercial grid controls

including ADMS, DERMS, microgrid controllers, and device level controls such as inverter controls

in a realistic laboratory environment.

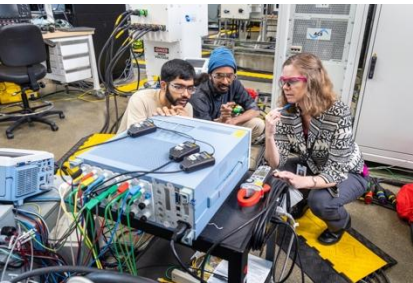
Advanced Distribution Management Systems Research

- Completed 14 projects; 6 active projects
- Worked with 12 distinct utilities, e.g., Xcel Energy, HCE, Southern Company, Portland General Electric
- And 10 commercial grid control vendors, e.g., Schneider Electric, OSI, Oracle, Survalent

Microgrid Research

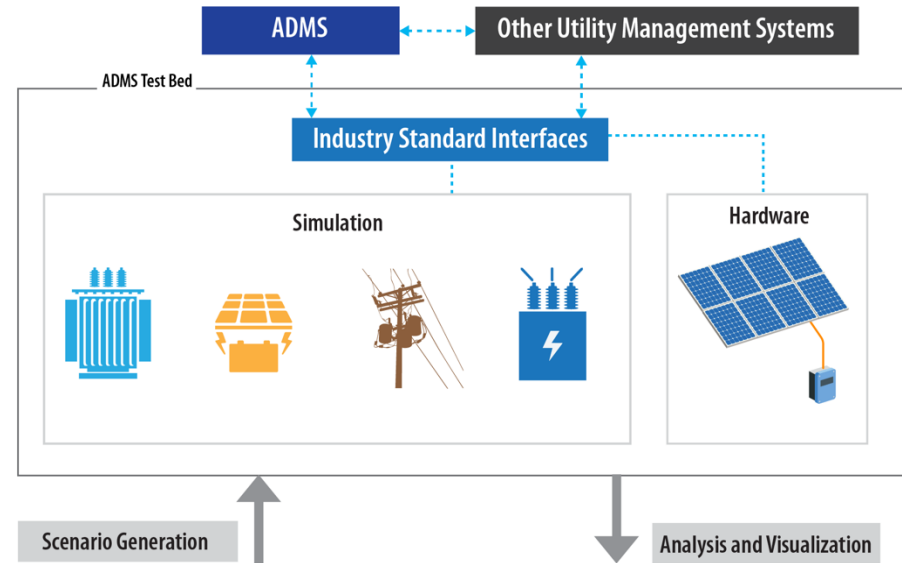
- Integrated with 7 commercial microgrid controllers, e.g., ETAP, S&C, Siemens, PXiSE
- Used for multiple real and planned microgrids, e.g., SDG&E's Borrego Springs microgrid.

Photo credits: Werner Stocum (NREL)



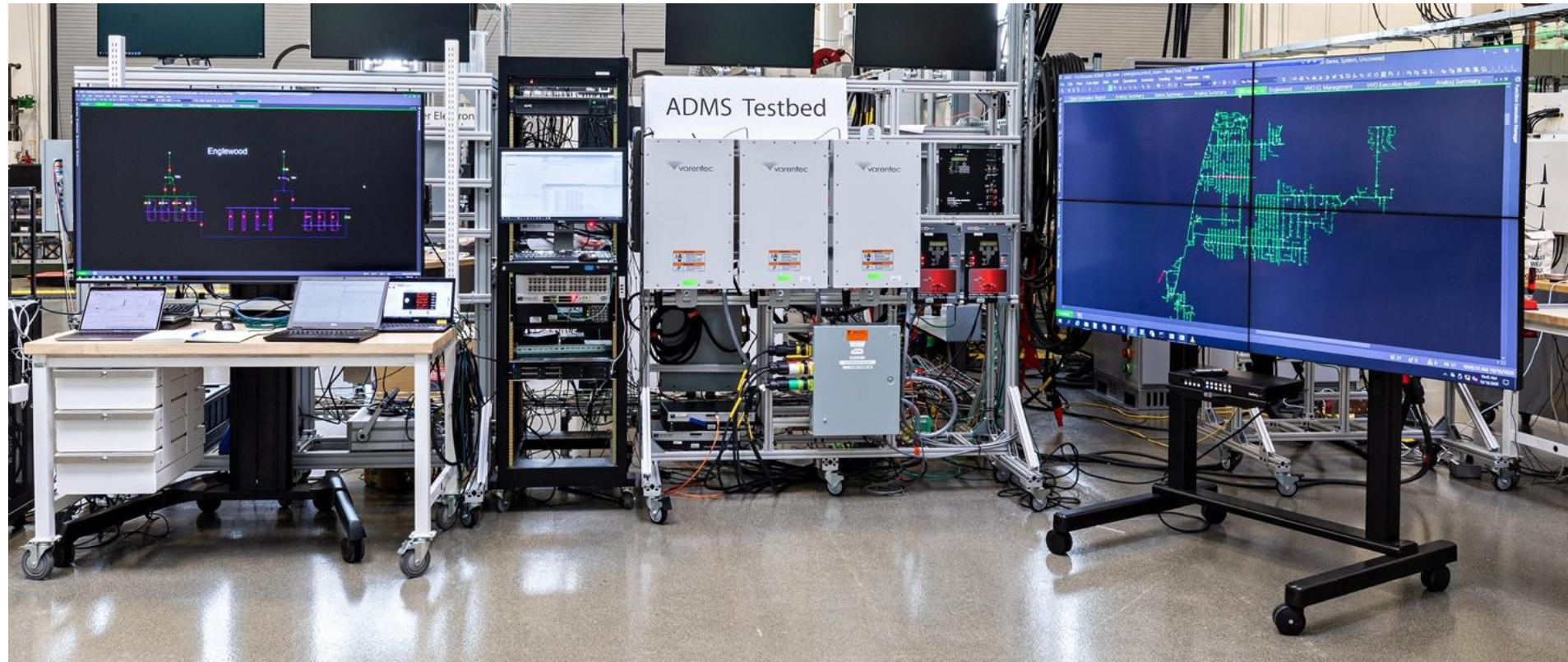
NLR's ADMS Test Bed

- 1 Perform realistic, real-time (hardware-in-the-loop) simulations of a real or representative distribution power system
- 2 Interface with commercial grid management software through industry-standard communications protocols
- 3 Evaluate controls performance using metrics and visualizations.



<https://www.nrel.gov/grid/adms-test-bed.html>

NLR's ADMS Test Bed



ARIES

Advanced Research on Integrated Energy Systems (ARIES) is a unique research platform developed by NLR and DOE.



Energy Systems Integration Facility (ESIF)



Flatirons Campus



Virtual Emulation Environment

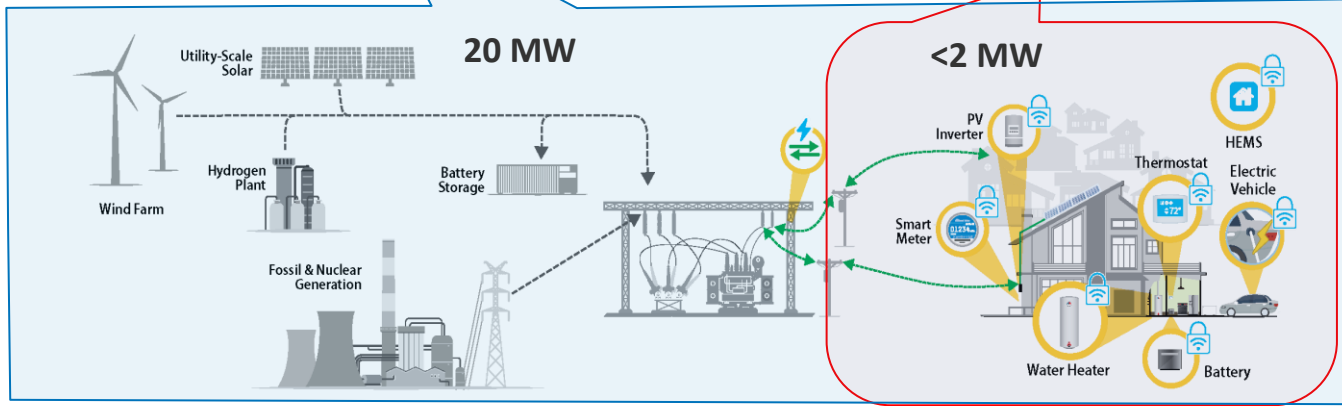


IESS

Photos by NREL



ESIF



Generation & Storage

Transmission/
Distribution & Storage

Loads & Storage

Virtual Emulation

ARIES is a globally unique research capability that can be used to demonstrate that DERs can operate in real-time energy markets and provide reliable and resilient grid services.

ADMS Test Bed use cases:

1. ADMS network model quality impact on VVO
 - **Xcel Energy** + Schneider Electric
2. Peak load management with ADMS and DERMS
 - **Holy Cross Energy** + Survalent & NLR's RTOFP
3. AMI-based, data-centric grid operations
 - **SDG&E** + GridAPPS-D
4. FLISR in the presence of DERs
 - **Central Georgia EMC** + Survalent
5. DER controls strategies for T&D grid services
 - **Xcel Energy** + GridAPPS-D
6. Federated DERMS for high PV systems
 - **Southern Company** + Oracle & GridAPPS-D
7. Co-optimizing grid and facility operations
 - **Shell** + Spirae
8. System restoration with improved fault tracking
 - **Israel Electric Company** + EGM
9. Microgrid and EV Managed Charging Demonstration
 - **Colorado Springs Utilities** + SGS
10. Flexible Feeder
 - **Portland General Electric** + OSI

ADMS Test Bed capabilities used by:

11. Non-wires alternatives (**Holy Cross Energy**)
12. ECO-IDEA (**Xcel Energy**)
13. GO-SOLAR (**HECO**)
14. SolarExpert (**Duke**)
15. RONM (**Cobb EMC**)
16. PIVA (**SDG&E**)
17. *SALMON* (**Portland General Electric**)
18. FAST-DERMS (**Southern Company, ComEd**)
19. REORG (**Holy Cross Energy**)
20. AI-PhyX
21. SensorMAP (**PGE; Duquesne Light Company**)

16 Completed

5 Active

ADMS network model quality impact on VVO

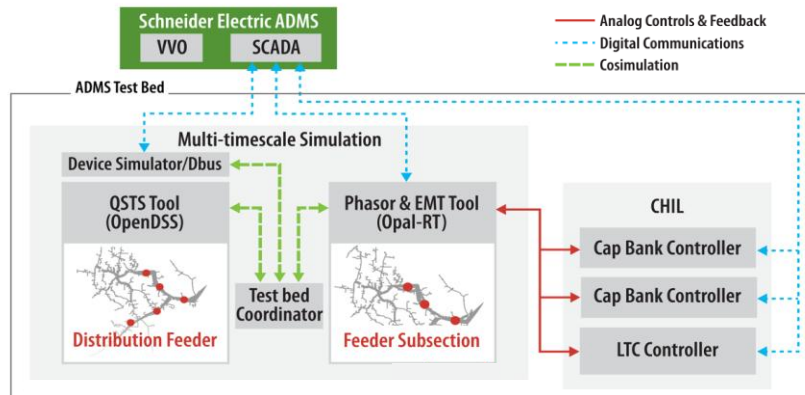
Completed

Partners:

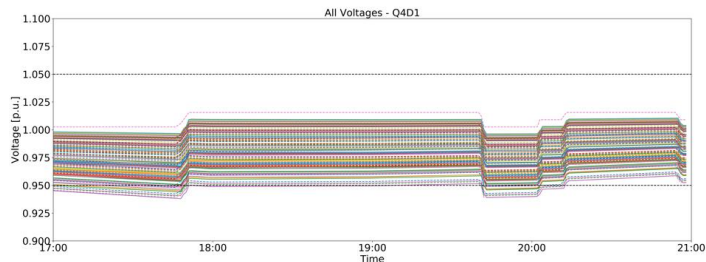
- Xcel Energy
- Schneider
- PNNL
- EPRI
- OPAL-RT

Controls:
ADMS

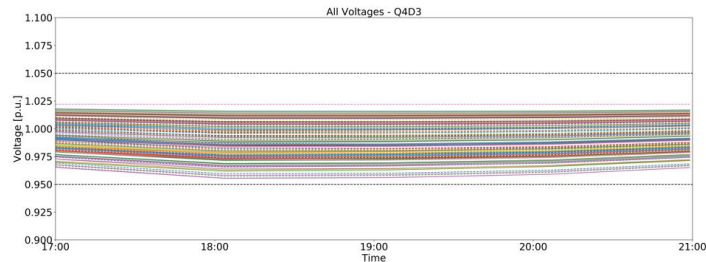
- **Objective:** Evaluate the impact of the quality of the ADMS network model on Volt-Var optimization (VVO).
- **Findings:** A low-quality ADMS model resulted in numerous voltage exceedances and multiple utility equipment operations, while the highest quality model resulted in significant reductions in both and showed an increase in energy savings



Q4D1 (High model quality; feeder head-only measurements)



Q4D3 (High model quality; feeder head + 10 AMI measurements)



I. Mendoza, A. Pratt, H. V. Padullaparti, S. Tiwari, and M. Baggu, "Model Quality and Measurement Density Impact on Volt/Volt Ampere Reactive Optimization Performance," *Energies*, July 2024.

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions (FAST-DERMS)

Research Controls

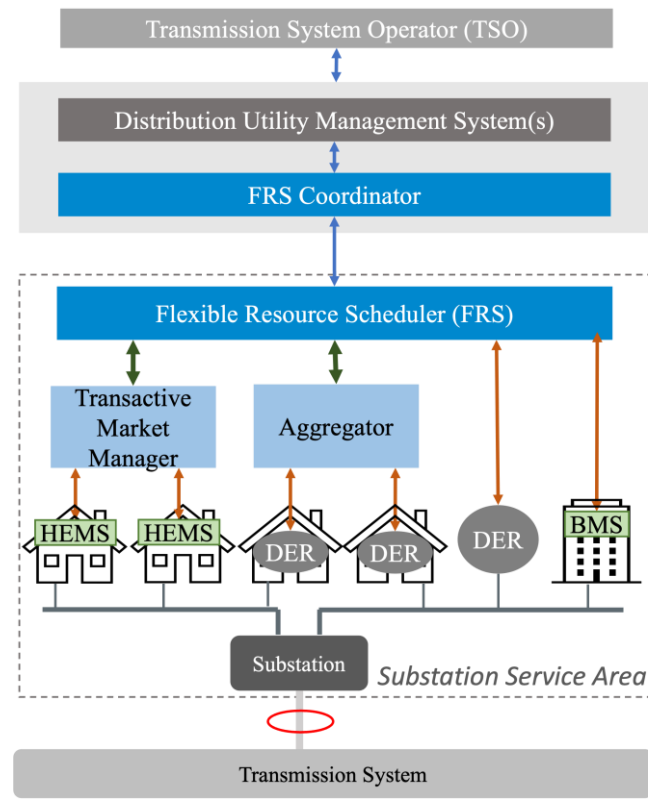
Partners:

- LBNL, PNNL, ORNL, EPRI
- SDG&E, Southern Company
- Oracle

Controls:

*DERMS,
DER aggregator,
transactive HEMS*

- The FAST-DERMS control structure is hierarchical and distributed, with Flexible Resource Schedulers (FRSs) controlling power flow at substations and managing DERs downstream of the substation. It provides:
 - **Aggregation and Dispatch of DERs:** Provides a framework for utility-scale and small-scale DERs to support the grid, either directly, or through aggregators or a transactive market.
 - **Predictability:** Transforms the net load of a distribution substation into a predictable, controllable resource akin to a conventional generator from the perspective of the transmission system operator (TSO).



J. S. MacDonald, M. Baudette, V. R. Motakatla and Y. Lin, "An Introduction to the Federated Architecture for Secure and Transactive Distributed Energy Management Solutions (FAST-DERMS)," 2024 Annual Conference of the IEEE Industrial Electronics Society (IECON), Chicago, IL, Oct 2024.

Modeling and Co-optimizing Grid Operations and Facility Operations

Recently Completed

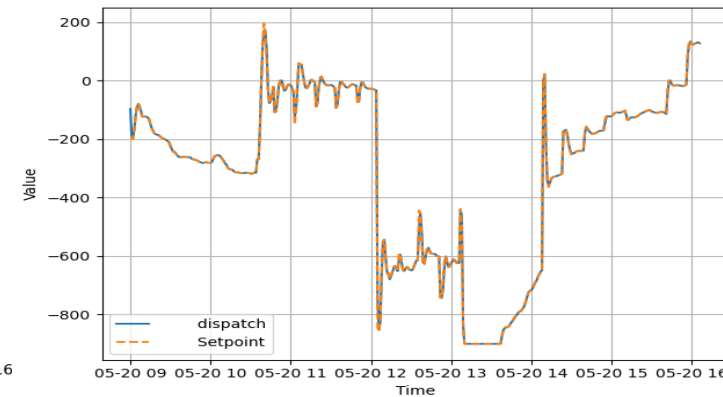
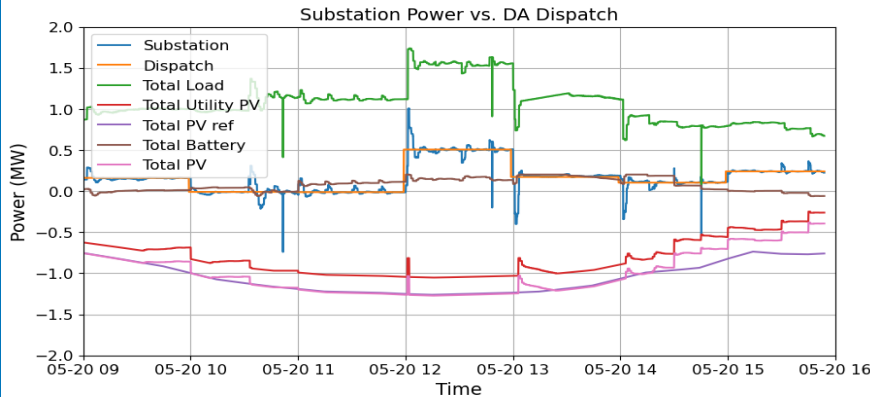
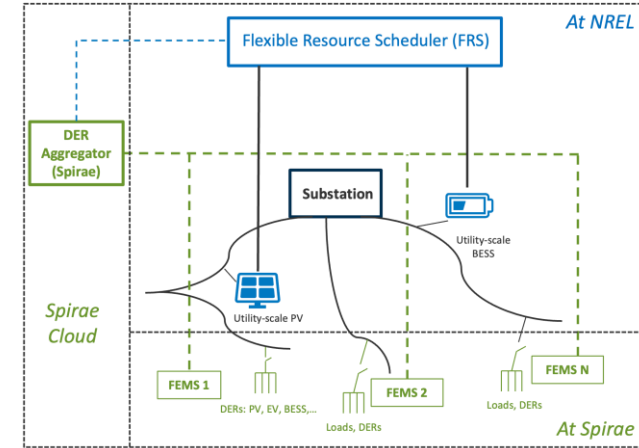
Partners:

- Spirae, LLC
- Shell

Controls:

DERMS,
DER aggregator,
facility EMS

- **Objective:** Demonstrate grid-edge controls—at facility and aggregator level—working in conjunction with DERMS to dispatch aggregated grid-edge resources and deliver value to facility and grid operations.
- **Findings:** Test bed allows utilities and developers to study complex interactions between control systems and their impact on the grid and facilities.



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