NREL
Transforming ENERGY

Multidisciplinary Skill Needs as a Response to Global Challenges in Power and Energy

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Chief Engineer, NREL

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Outline

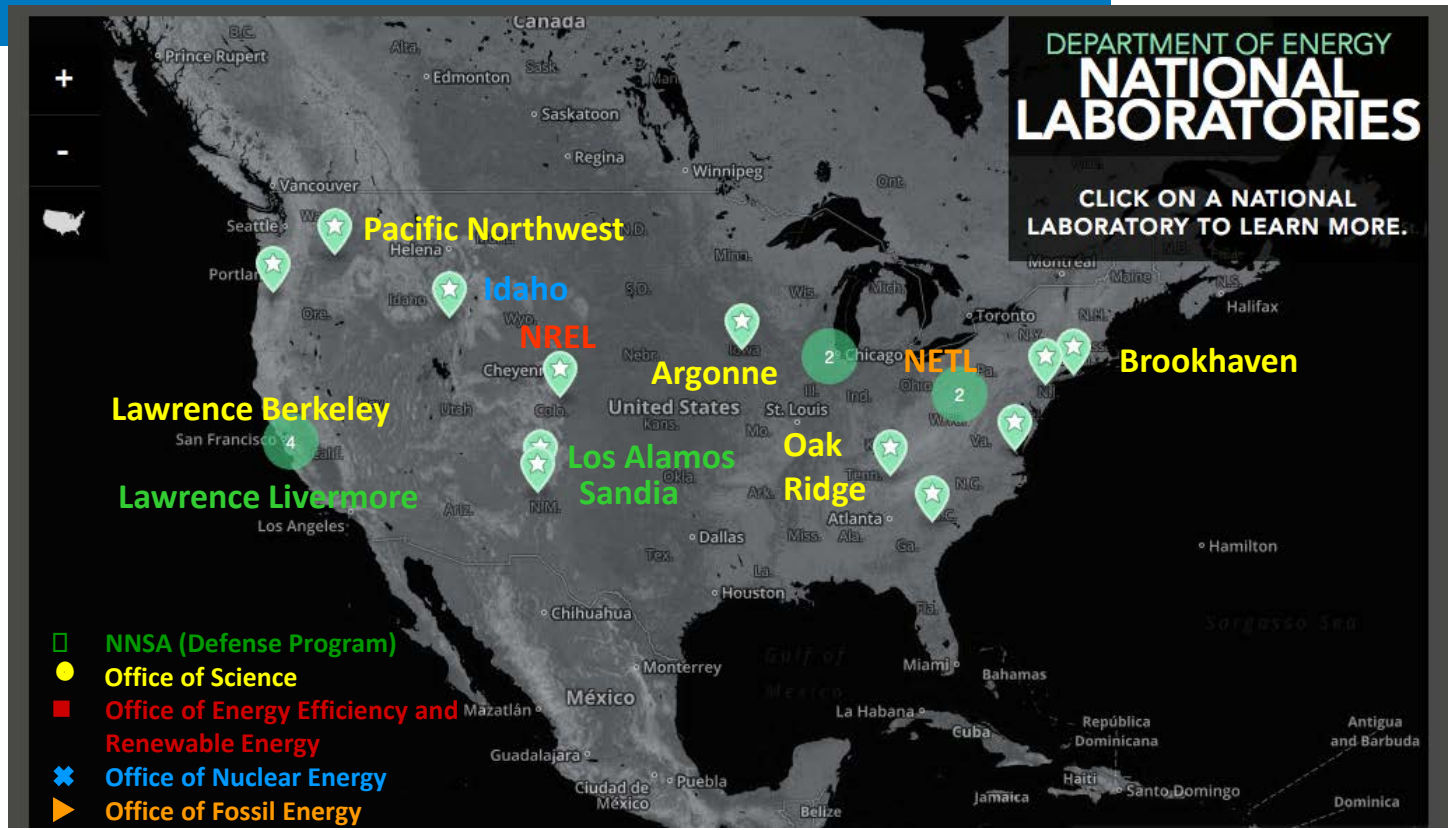
- Brief biography
- Brief overview of NREL
- Thoughts on multi-disciplinary skills
- Example: NREL's ADMS Test Bed

- *Internship opportunities*

Professional Background

- **Education**
  - B.Eng. & M. Eng., Electronic and Electrical Engineering, University of Stellenbosch, South Africa, 1993 & 1995
  - Ph.D. Oregon State University, 1999; *Specialization : Power Electronics*
- **Electrical Engineer,** Advanced Energy, Fort Collins, CO
  - *Power supplies for semiconductor & glass industries, PV*
- **Senior Engineer,** Intel Corp/ Intel Labs, Hillsboro, OR
  - *Power delivery: data center, power supply, motherboard, on-silicon*
  - *Smart grid: home & microgrid energy management*
- **Chief Engineer,** NREL, Golden, CO
  - Energy management systems at the building, microgrid and distribution system level
  - Co-simulation and hardware-in-the-loop evaluation

DOE National Laboratories Overview



Source: http://energy.gov/maps/doe-national-laboratories

The National Renewable Energy Laboratory (NREL) is operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE).

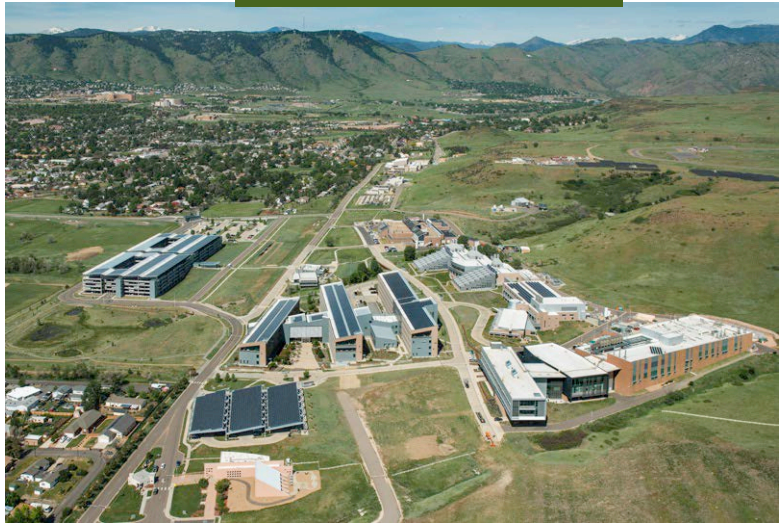
NREL Overview

- NREL is the only national laboratory ***dedicated*** to renewable energy and energy-efficiency research and development (R&D).
- Research ranges from fundamental ***science to technology*** solutions.
- ***Collaboration*** with industry and university partners is a hallmark.

Flatirons Campus in Boulder, CO

Photos by NREL

Main Campus in Golden, CO



ESIF—A National User Facility

NREL's largest R&D facility (182,500 ft^2/20,000 m^2)

Space for ~200 NREL staff and research partners

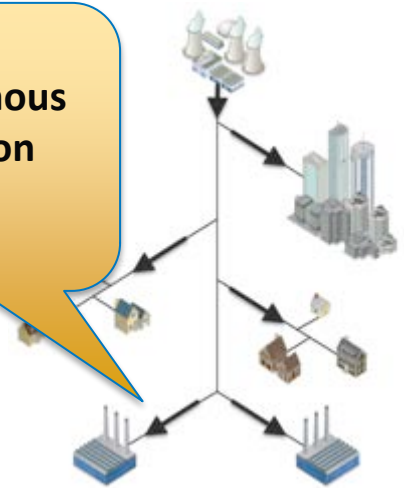
Key research areas for the ESIF include:

- **Cybersecurity**
- **Energy resilience**
- **Grid systems integration**
- **Building technologies and thermal**
- **Advanced mobility**
- **Renewable fuels/gas and energy.**

Photos by NREL

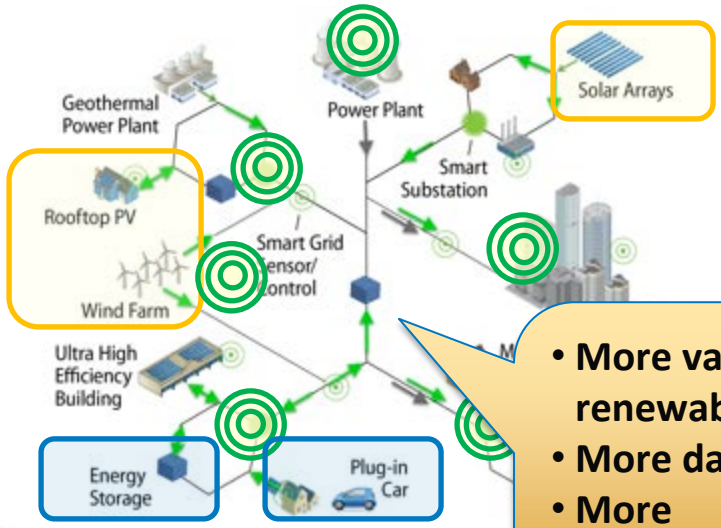
Evolution of the Power System

Current Power System



- Large synchronous generation
- Central control.

Future Power Systems



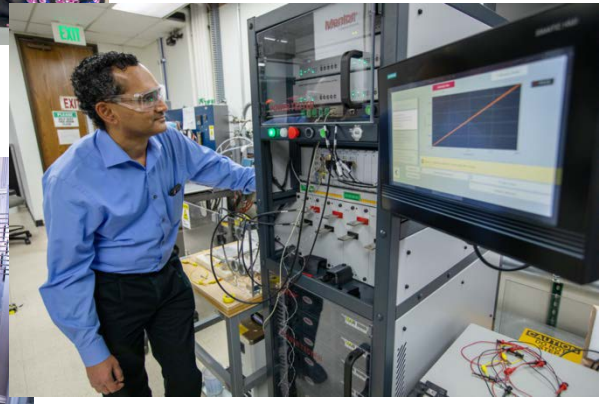
- More variable renewables
- More data
- More distributed resources

New challenges in a modern grid:

- Increasing levels of power electronics-based VRE: solar and wind
- More use of communications, controls, data, and information (e.g., smart grids)
- Other new technologies: electric vehicles (EVs), distributed storage, flexible loads
- Becoming highly distributed—more complex to control

In-Demand Skills
for Modernized Grid Research, Development and Deployment

- Power Systems
  - Integration with gas & water
- Power Electronics
- Control Systems
  - Distributed and Robust Control
  - Optimization
- Embedded Systems/Firmware
- Software
  - Modeling & Simulation
  - Visualization
  - Data Analytics

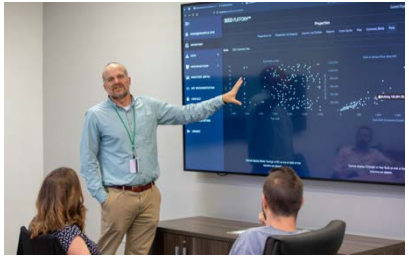


Photos by NREL

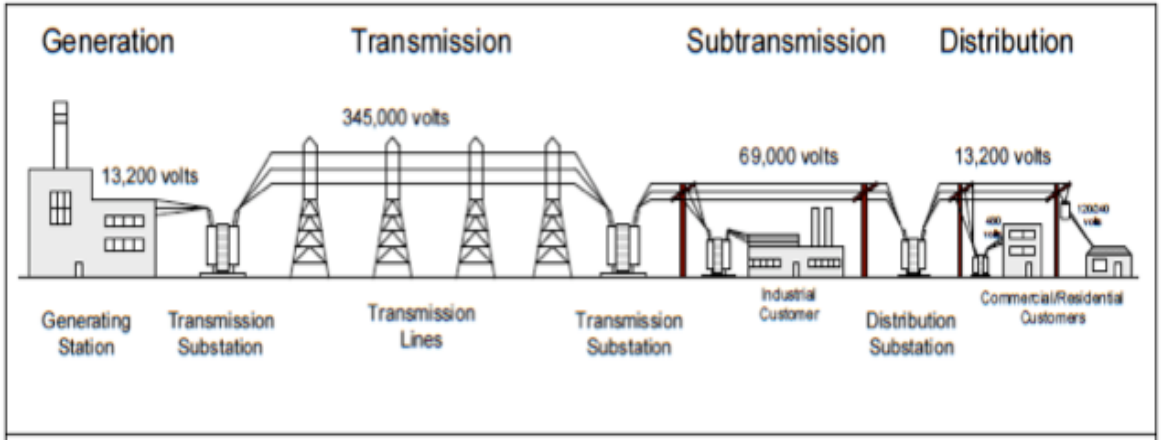
Soft Skills

- SWANs
  - Smart, hardWorking, Ambitious, Nice
- Writing
  - For technical and non-technical audiences
  - Proposals/grants/self-assessments
- Speaking
  - Formal presentations & “elevator pitch”
- Running effective meetings
- Project planning, including finances
- Wise use of flexible work options

Photos by NREL



Multi-faceted Electric Power Systems



Electric Power

Technical

$$$

Financial

Regulatory restrictions, e.g., FERC and state public utility commissions
Customer impact & response

Social

ADMS Test Bed

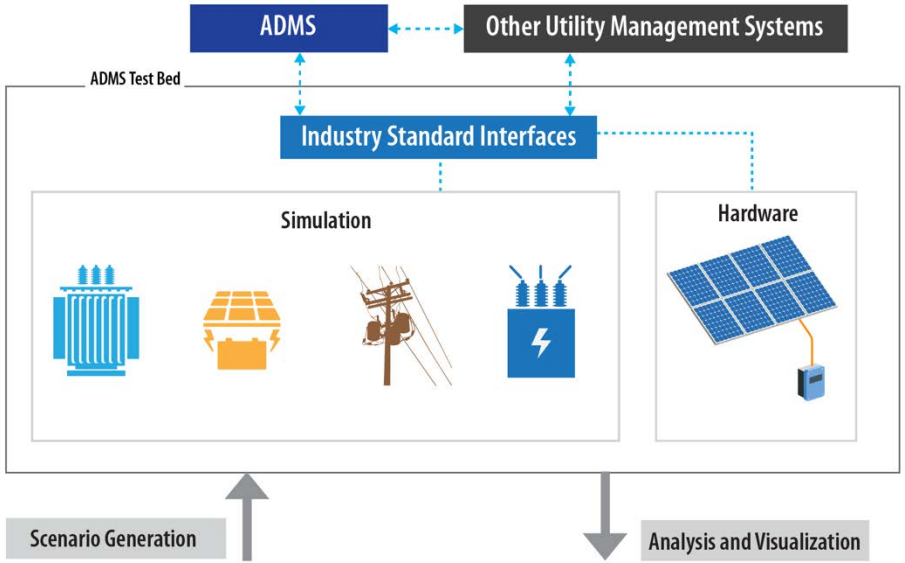
U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY

Goal: Accelerate industry adoption of ADMS to:

- Improve normal operations with high levels of distributed energy resources (DERs).
- Improve resilience and reliability.

Approach: Partner with utilities and vendors to evaluate specific use cases and applications to:

- Set up a realistic laboratory environment.
- Simulate real distribution systems.
- Integrate distribution system hardware.
- Use industry-standard communications.
- Create advanced visualization capability.



https://www.nrel.gov/grid/advanced-distribution-management.html

ADMS Test Bed

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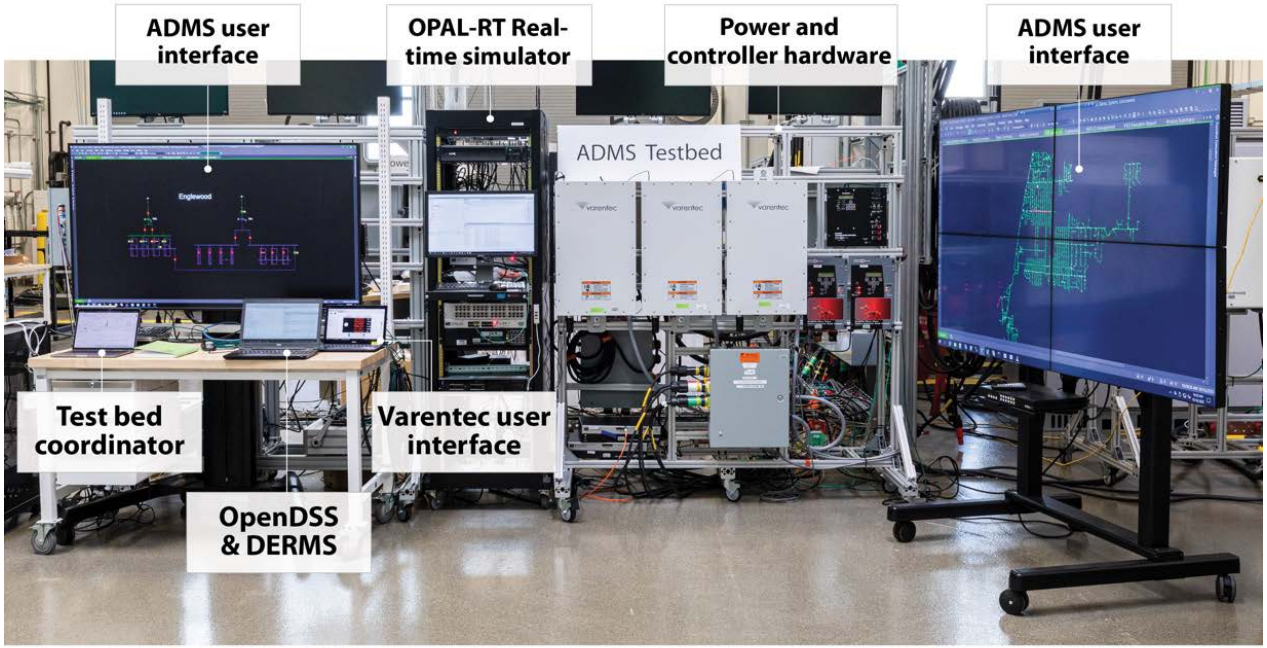
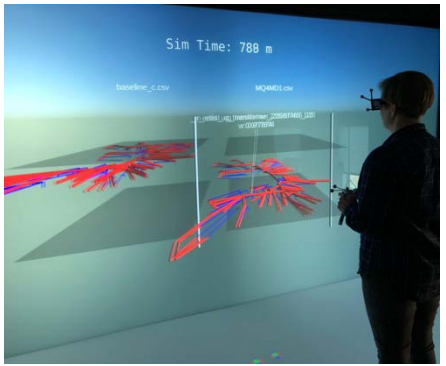


Photos by NREL

2D real-time visualization



3D visualization

ADMS Test Bed

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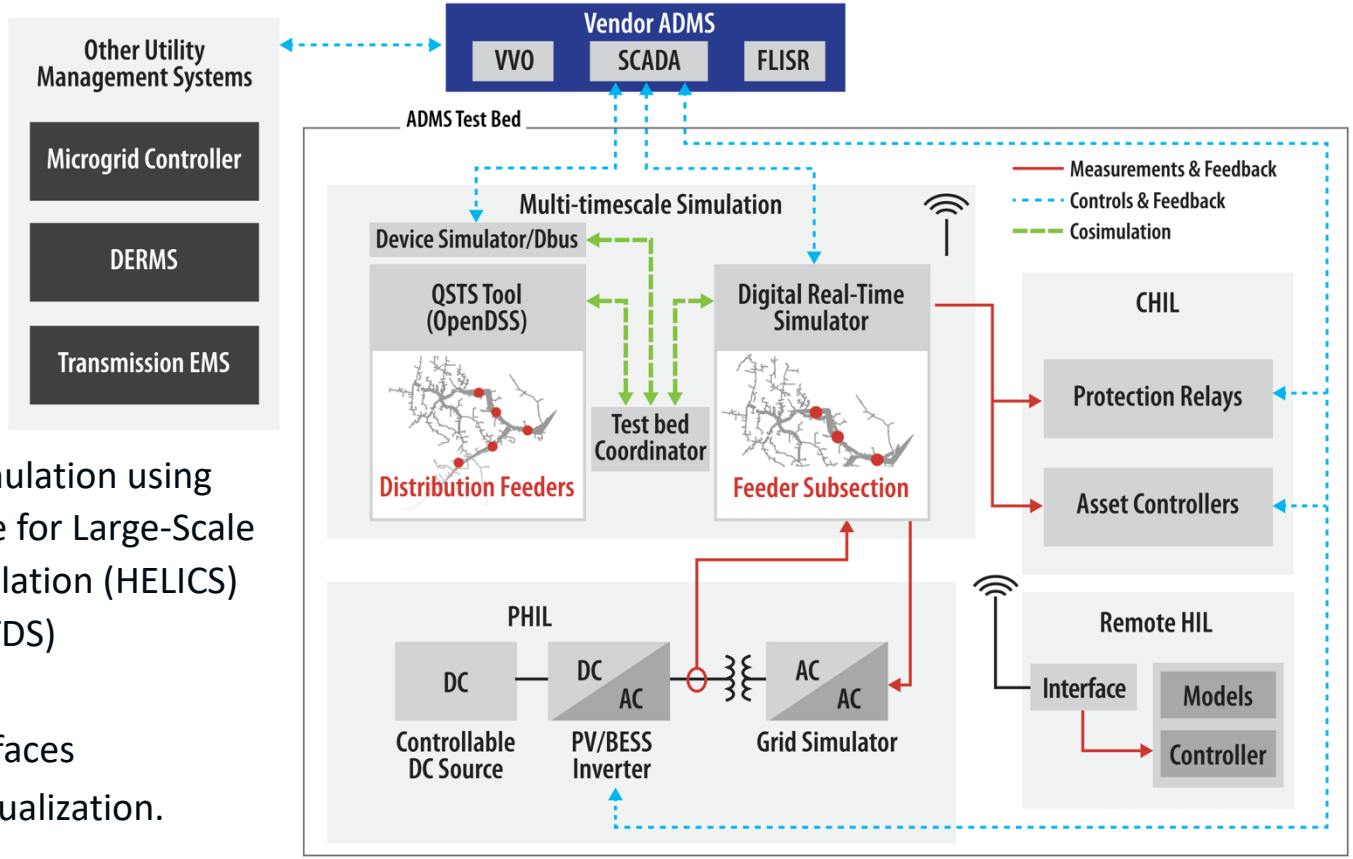
ADMS Test Bed capabilities include:

- Multi-timescale co-simulation using the Hierarchical Engine for Large-Scale Infrastructure Co-Simulation (HELICS) (OpenDSS/OPAL-RT/RTDS)
- Hardware integration
- Communications interfaces
- Data collection and visualization.



ADMS Test Bed
Use Case Development

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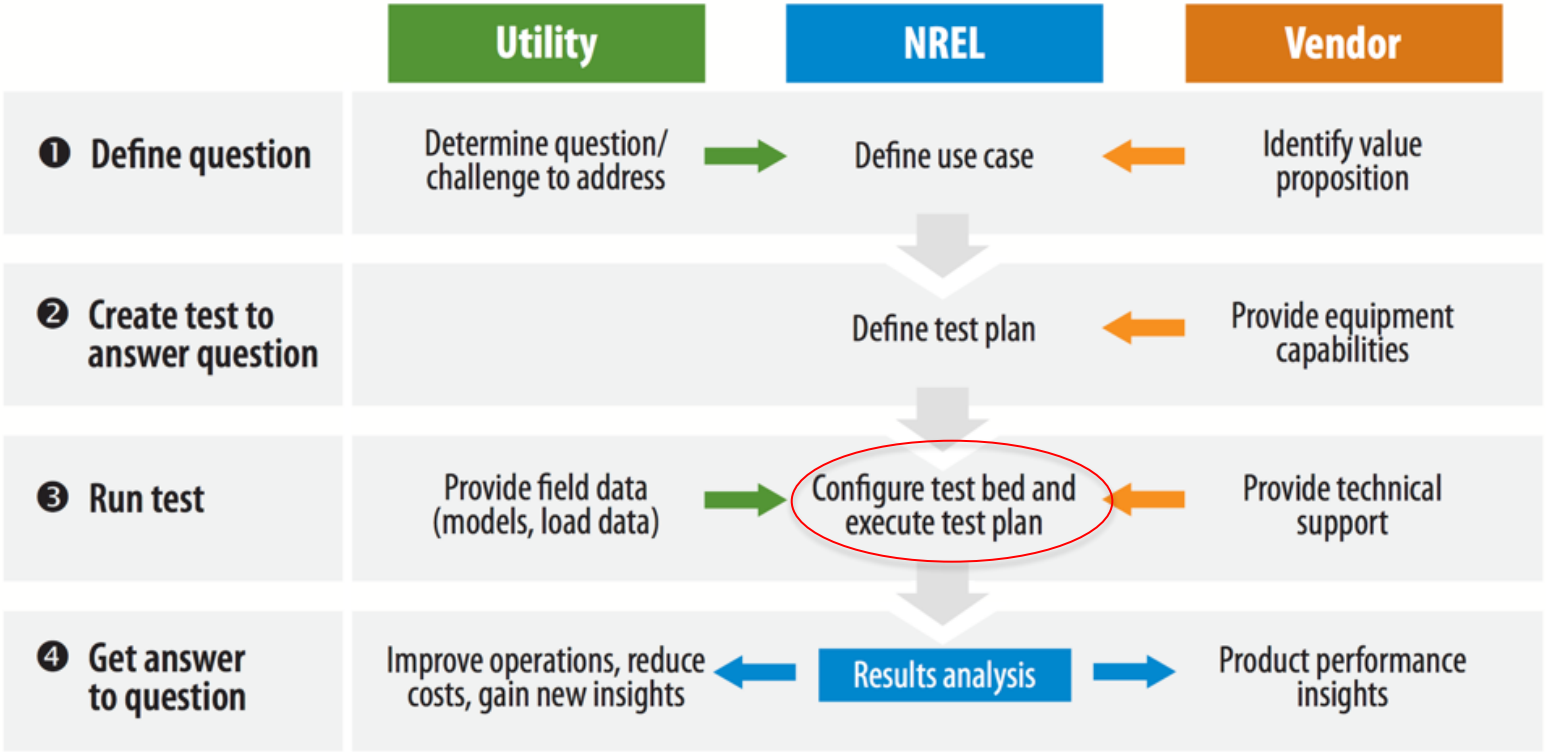
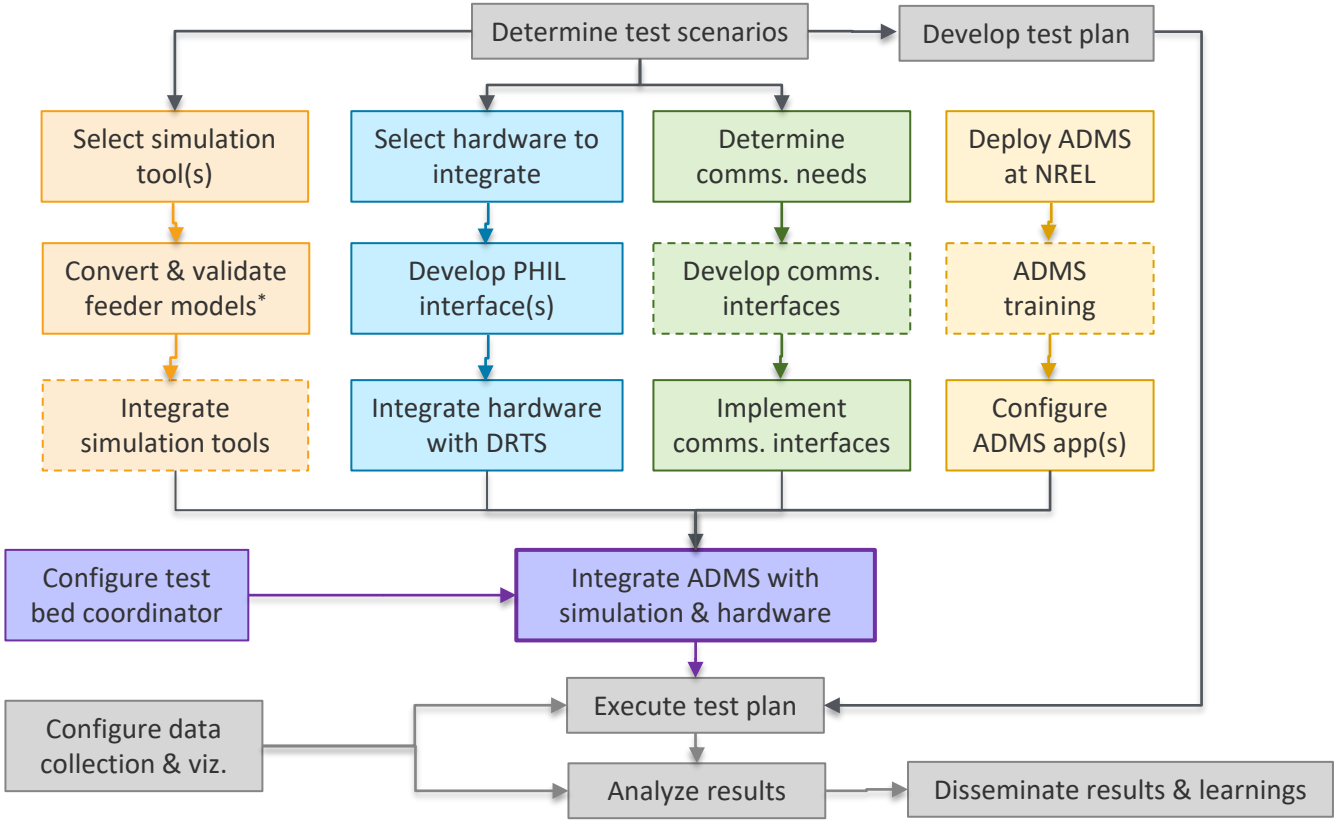


Configuring the Test Bed



* NREL's Distribution Transformation Tool (DiTTo): https://github.com/NREL/ditto.

ADMS Test Bed Use Cases

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- Peak load management with ADMS and DERMS
  - Holy Cross Energy/Survalent
- ADMS network model quality impact on VVO
  - Xcel Energy/Schneider Electric
- AMI-based, data-centric grid operations
  - SDG&E + GridAPPS-D
- FLISR in the presence of DERs
  - Central Georgia EMC/Survalent → August 2022
- Federated DERMS for high PV system
  - Southern Company/Oracle + GridAPPS-D → February 2023
- DER controls strategies for T&D grid services
  - Xcel Energy + GridAPPS-D → September 2022
- Modeling and co-optimizing grid operations and facility operations with interoperable ADMS, VPP, microgrids, and grid-edge DERs
  - Shell + Spirae → October 2023
- Integration of advance grid monitoring and analytics with ADMS FLISR application
  - IEC + EGM → December 2023

ADMS test bed capabilities used by:

- Non-wires alternatives
- ECO-IDEA
- GO-SOLAR
- SolarExpert
- FAST-DERMS
  - SDG&E, Oracle, EPRI + GridAPPS-D → April 2023
- Resilient Operation of Networked Microgrids (RONM)
  - SDG&E, Cobb EMC → Nov 2022
- REORG
  - Holy Cross Energy, Minsait ACS → Mar 2024
- PV Integration using a Virtual Airgap (PIVA)
  GridBright, SDG&E → Sep 2023

(Graduate) Internships

» Careers » Internships

- Find a Job
- Internships
  - Undergraduate Internships
  - Graduate Internships
- Postdoctoral Opportunities
- Workforce Development Affiliate Programs
- Discover NREL

Internships

NREL and the U.S. Department of Energy offer a wide variety of internship opportunities to full-time undergraduate and graduate students.

Undergraduate ›

Graduate ›

The Intern Experience

NREL is excited to be able to offer on-site, hybrid, and virtual internships. We see our interns as the workforce of the future, helping us drive our mission—and the nation—forward. Our interns:

- Gain access to state-of-the-art systems and seasoned mentors
- Strengthen skills through professional development
- Hear from world-class experts and top executives during our lecture series
- Learn about our lab buildings and the work going on by taking virtual tours
- Have fun and engage with other interns by joining clubs and resource groups.

https://www.nrel.gov/careers/internships.html

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