



DIGITAL REAL TIME SIMULATION EXPANSION AT NATIONAL RENEWABLE ENERGY LABORATORIES

MAYANK PANWAR

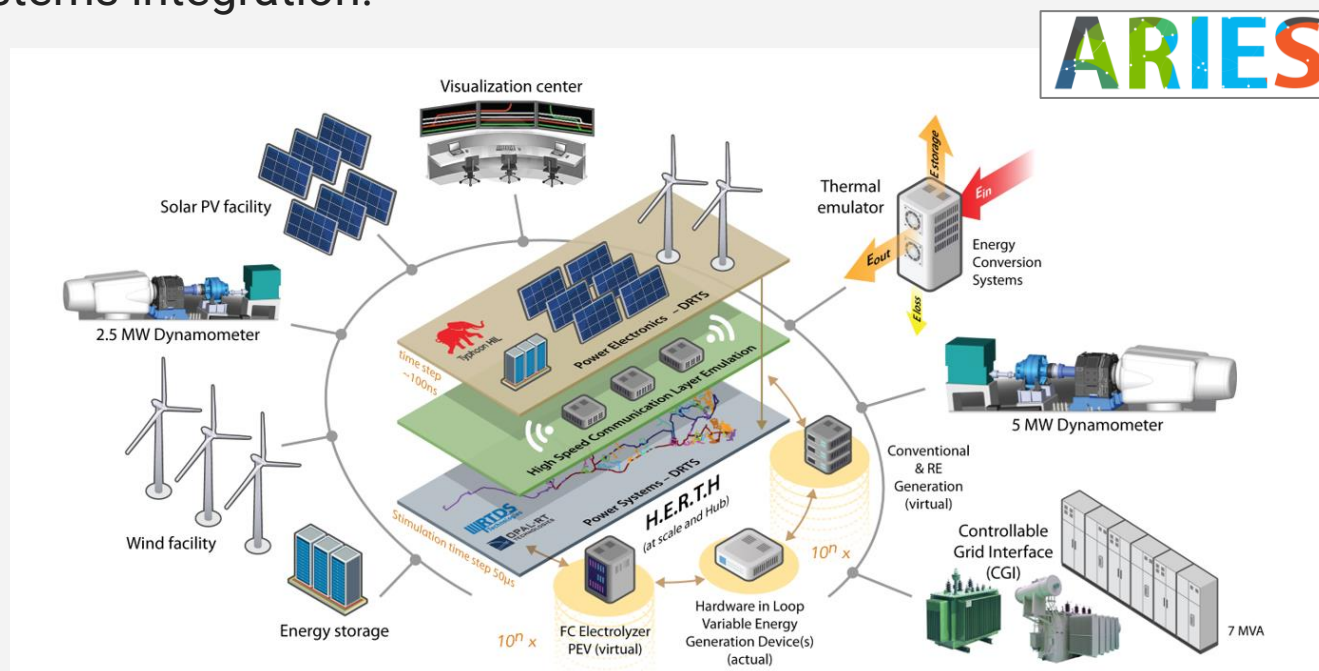
NATIONAL RENEWABLE ENERGY LABORATORY

NREL ADVANCED RESEARCH ON INTEGRATED ENERGY SYSTEM – ARIES

ARIES unites research capabilities at multiple scales and across sectors to create a platform for understanding the full impact of energy systems integration.

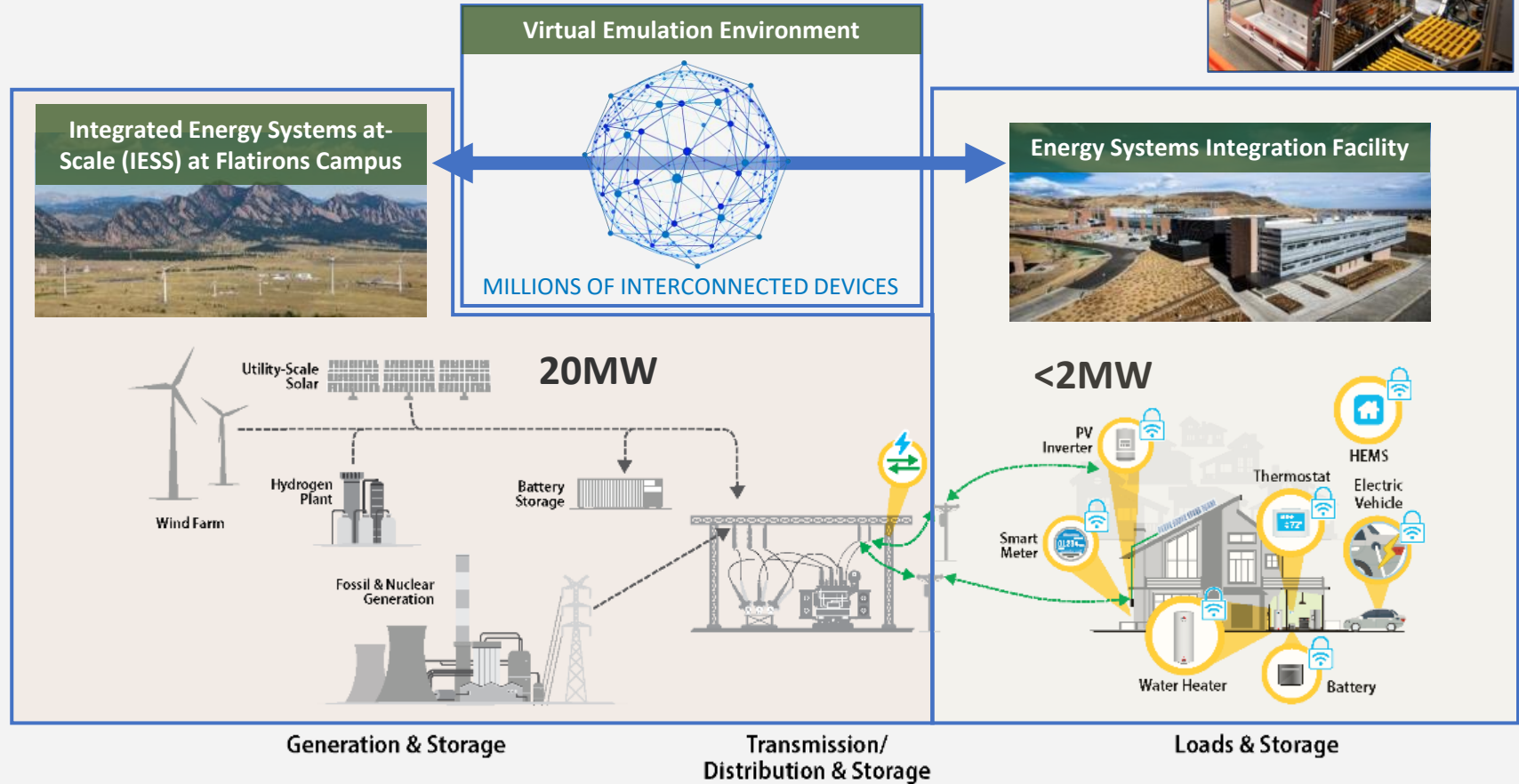
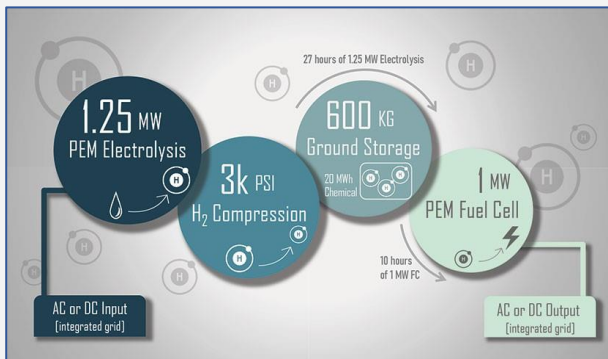
ARIES addresses the risks and opportunities of widescale integration across five research areas.

- Energy Storage
- Power Electronics
- Hybrid Energy Systems
- Future Energy Infrastructure
- Cybersecurity



ARIES: Advanced Research on Integrated Energy Systems | NREL

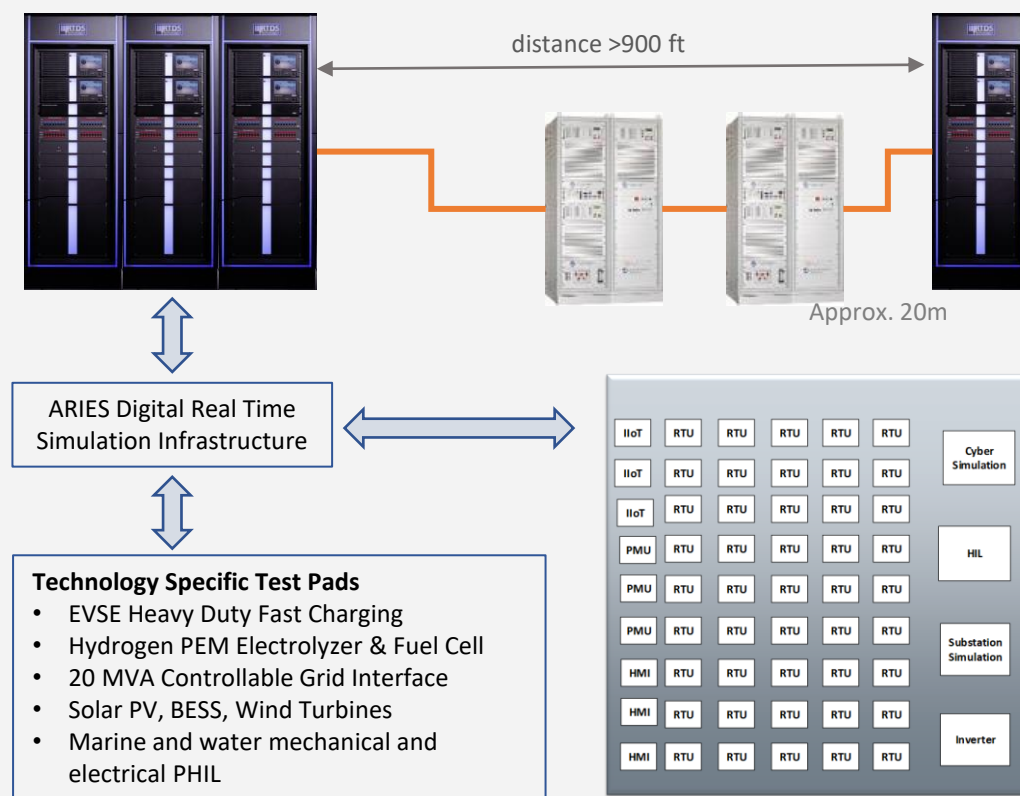
NREL ARIES – ASSETS OVERVIEW



MULTI-TECHNOLOGY AT-SCALE INTEGRATION

Research Infrastructure Setup for Flexibility in Configuration

- Flexibility in experiment configurations to serve multiple projects.
- Focus on At-scale Integration and Validation
 - **Distribution Automation**
 - Electric Vehicle Service Equipment
 - Building Energy Management Systems
- Large-scale Controller HIL
 - Currently 600 devices (Rasp PI)
 - End of FY23: 5000 devices
 - FY24: 10,000 devices



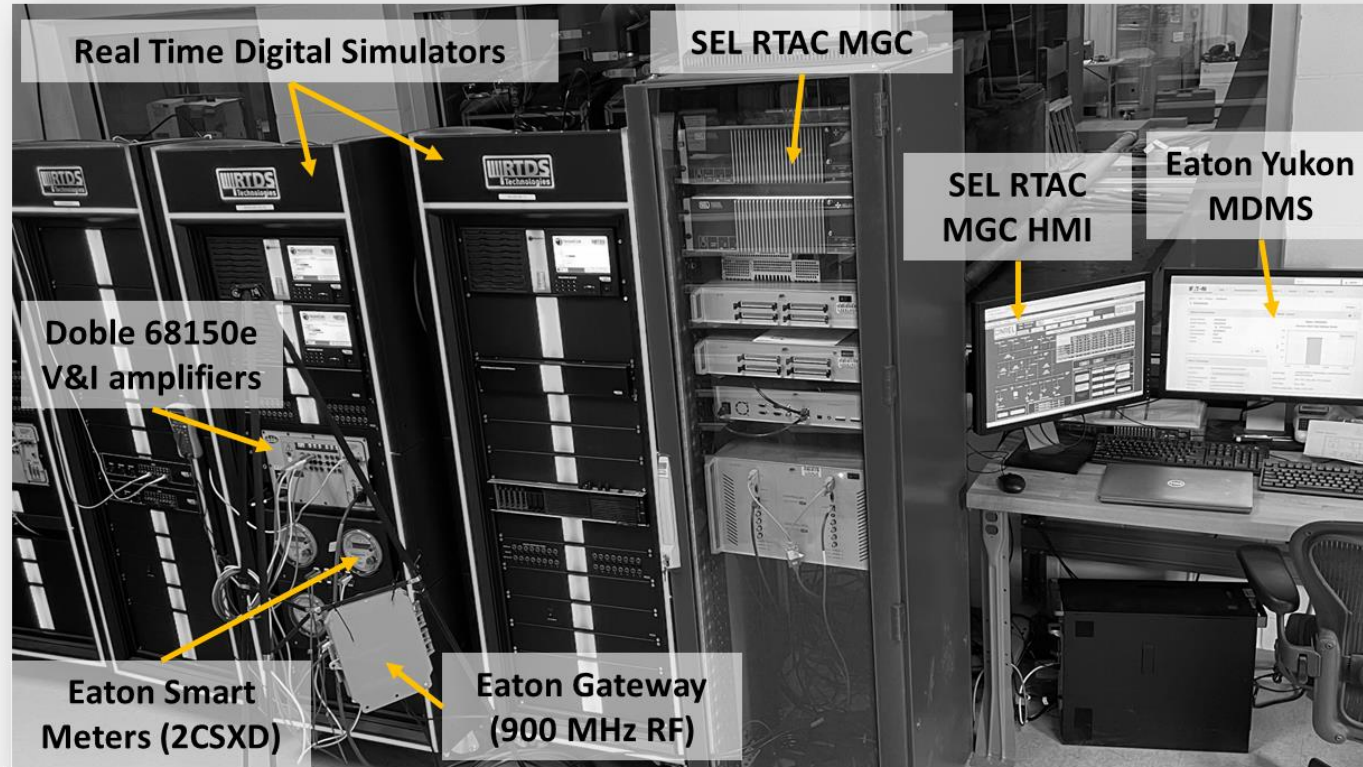
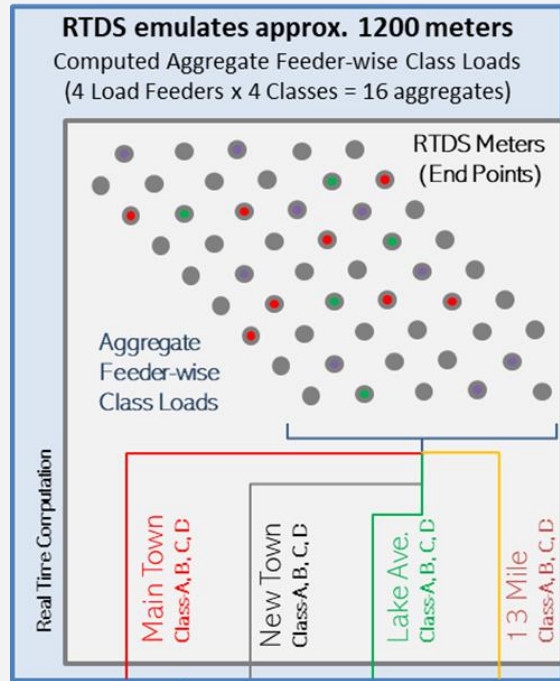
MULTI-TECHNOLOGY SYSTEM INTEGRATION

Multiple Vendor Integration and CHIL Testing

- Focus on At-scale Integration and Validation
 - **Distribution Automation**
 - Electric Vehicle Service Equipment
 - Building Energy Management Systems
- Grid Modernization RADIANCE Project in Cordova, Alaska.
 - Integration of SEL RTACs, Siemens IPC, Eaton AMI with RTDS.
 - IFAT Completed in May 2023.
 - FAT & field deployment by Sep. 2023.



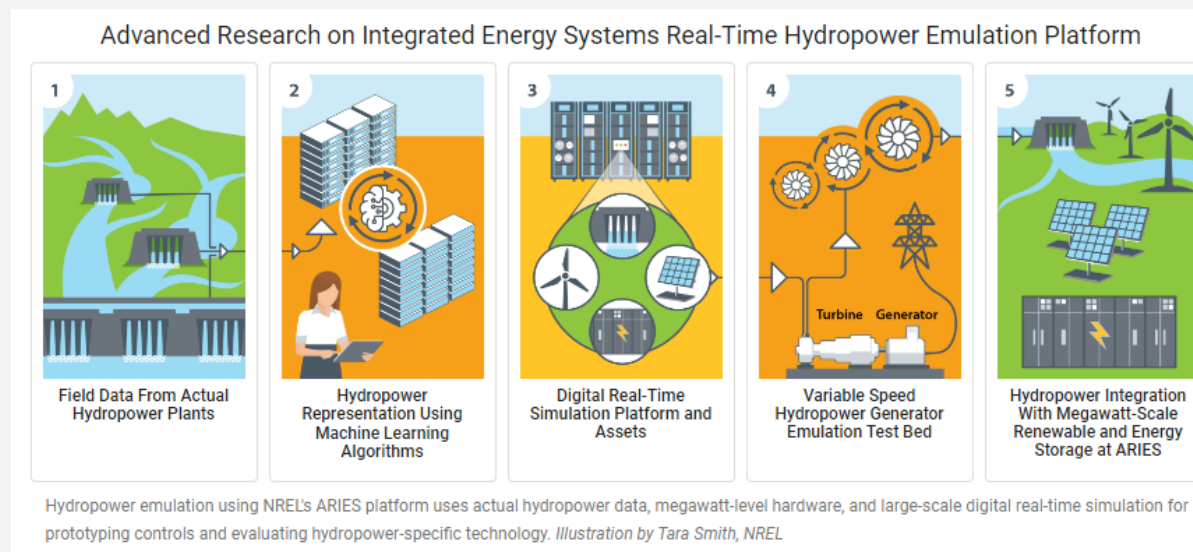
MICROGRID REAL TIME AUTOMATION W/ AMI



REAL TIME EMULATION OF ENERGY SYSTEMS

MW-scale Emulation of Hydropower and Grid Integration

- VFDs with electrical motors for mechanical shaft power at regulated torque and speeds.
 - Back-to-back or tandem compound for external device under test.
- Scalable emulation for inertia and capacities
 - Operation under different control configurations and hydrodynamics.
 - Advanced PSH operation and designs.
 - Coordinated controls for Hydro+X

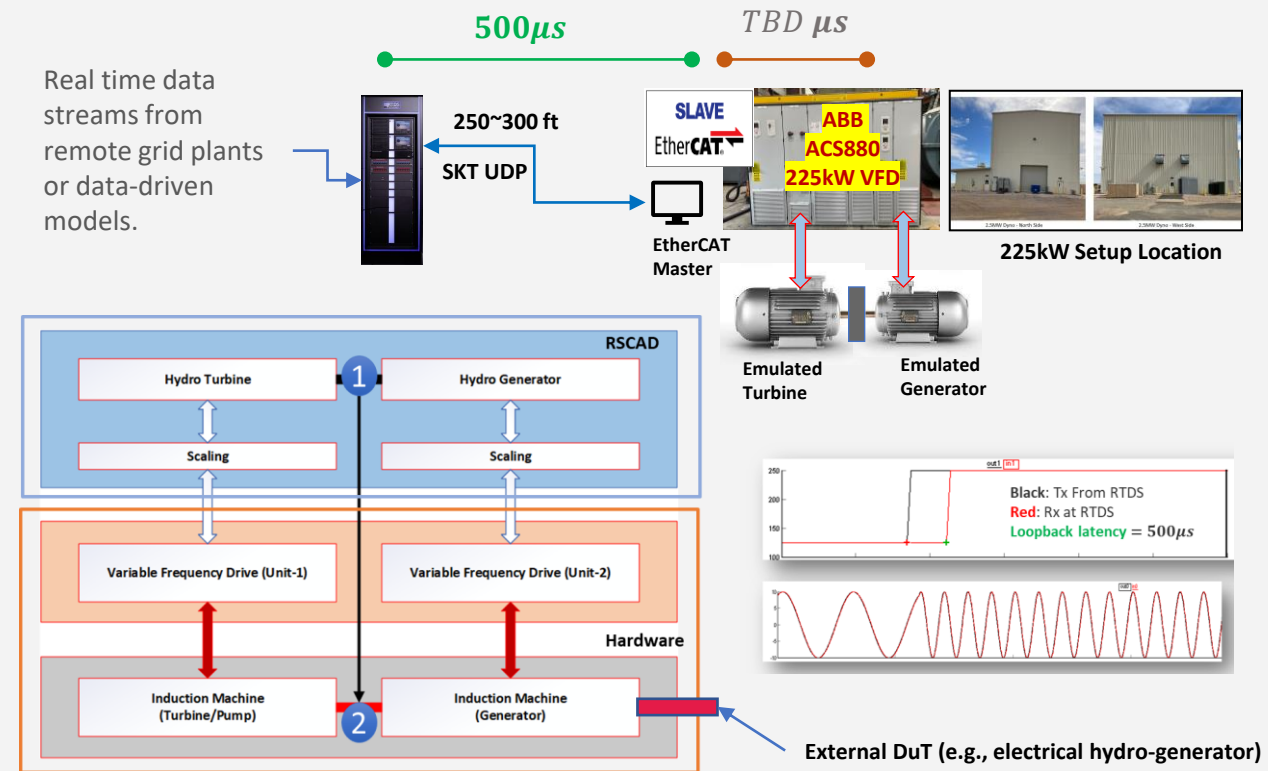


[Hydropower Emulation Platform](#) | [Water Research](#) | [NREL](#)

REAL TIME EMULATION OF ENERGY SYSTEMS

Dynamometer for Mechanical & Electrical PHIL (2x1.25 MW)

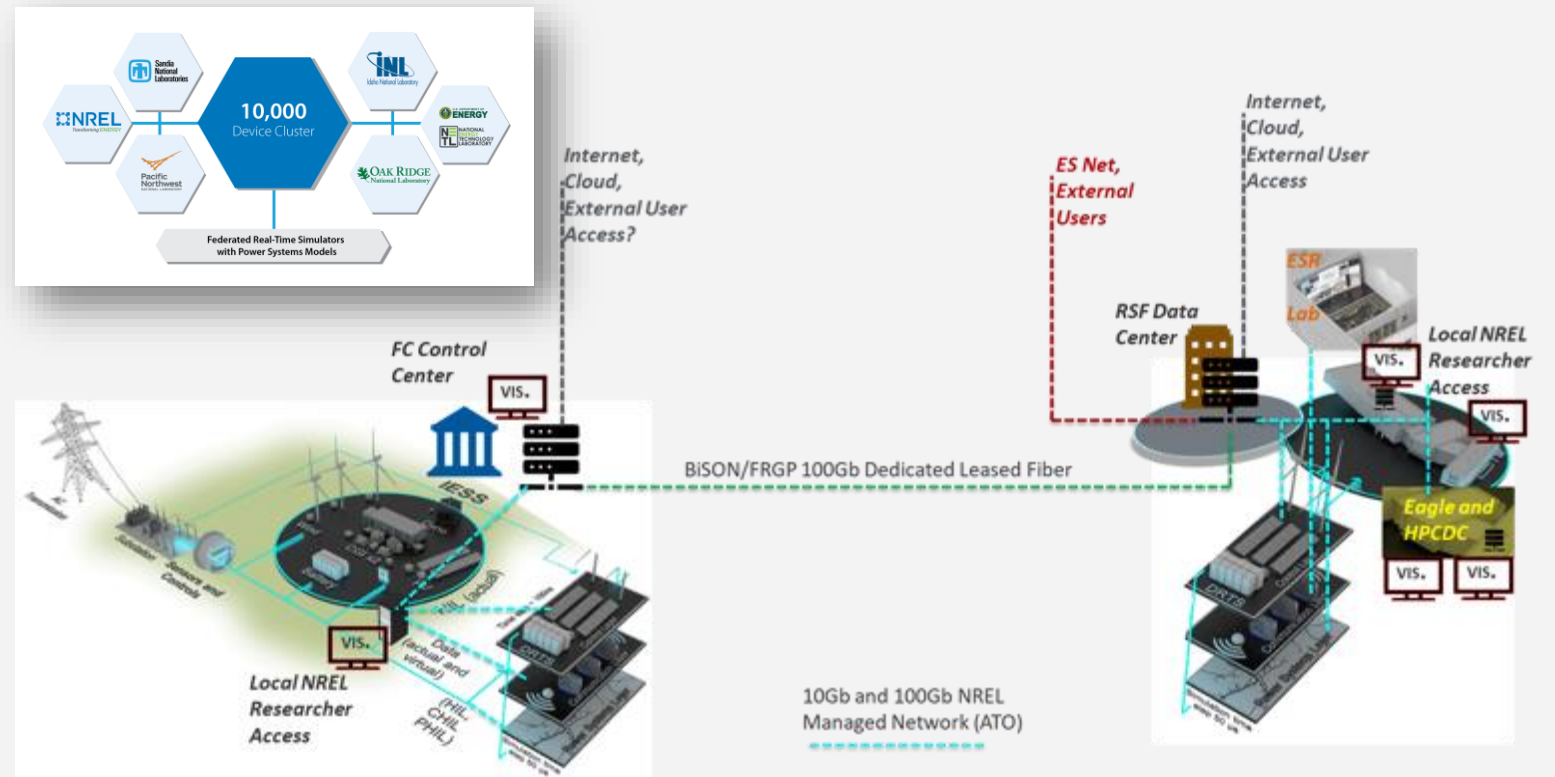
- VFDs with electrical motors for mechanical shaft power at regulated torque and speeds.
 - Back-to-back or tandem compound for external device under test.
- MW-scale platform is being developed for hydropower emulation.
 - Current integration with 225 kW VFD
 - End of FY24: expansion to 2.5 MW



REAL TIME CONNECTIVITY VIA ESNET OSCARS

Leveraging Office of Science's Energy Sciences Network OSCARS

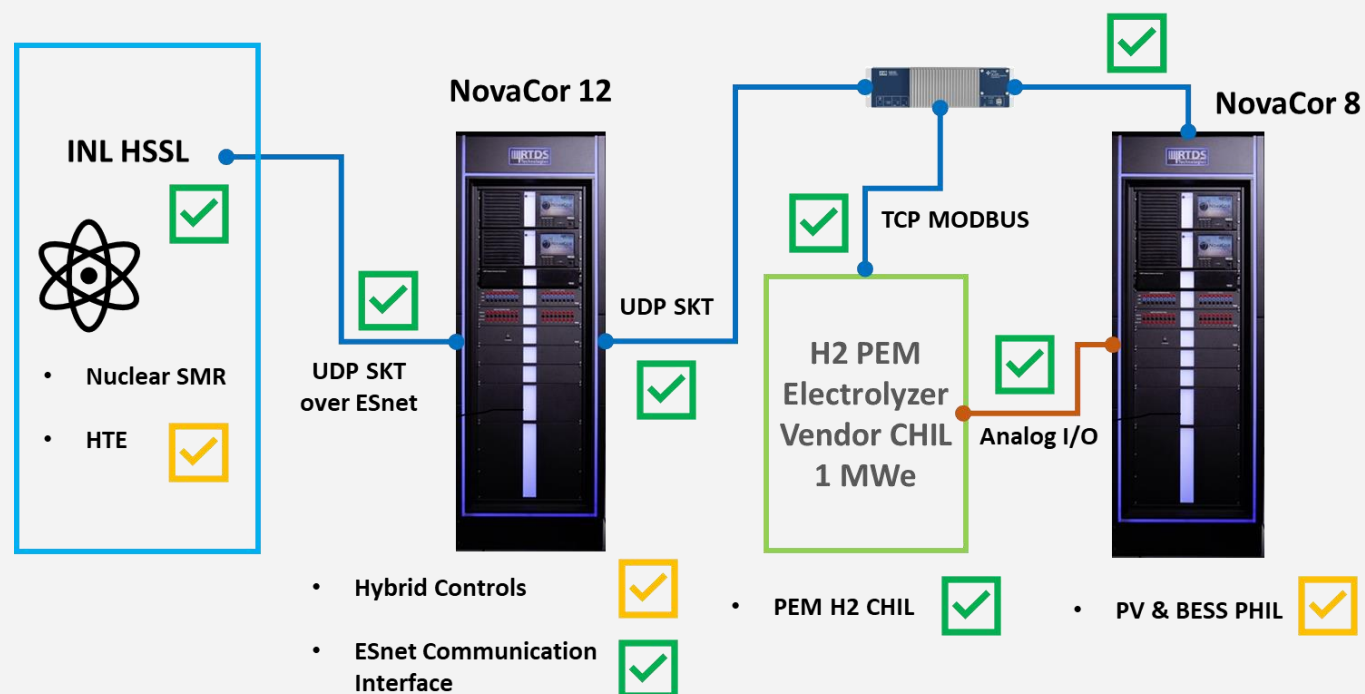
- For point-to-point without VPN, for lower and consistent latency.
- Leverage energy technology devices and infrastructure, domain expertise and integration research via real-time data exchange.



REAL TIME CONNECTIVITY VIA ESNET OSCARS

NREL-INL Nuclear Hybrid Renewable Hydrogen Use-case (Jan 2023)

- High-temperature electrolyzer and nuclear small modular reactor (SMR) thermal dynamics emulated at INL.
- Remote SMR output used to drive RSCAD generator model.
- Solar PV & BESS PHIL, H2 PEM CHIL at NREL



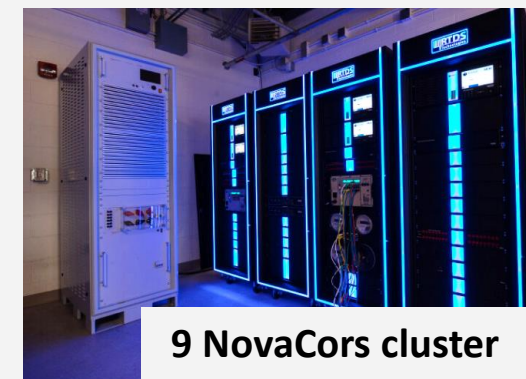
<https://www.nrel.gov/news/features/2023/combined-superlab-demonstrates-unique-hybrid-power-plant.html>

<https://www.es.net/news-and-publications/esnet-news/2023/combined-superlab-demonstrates-unique-hybrid-power-plant/>

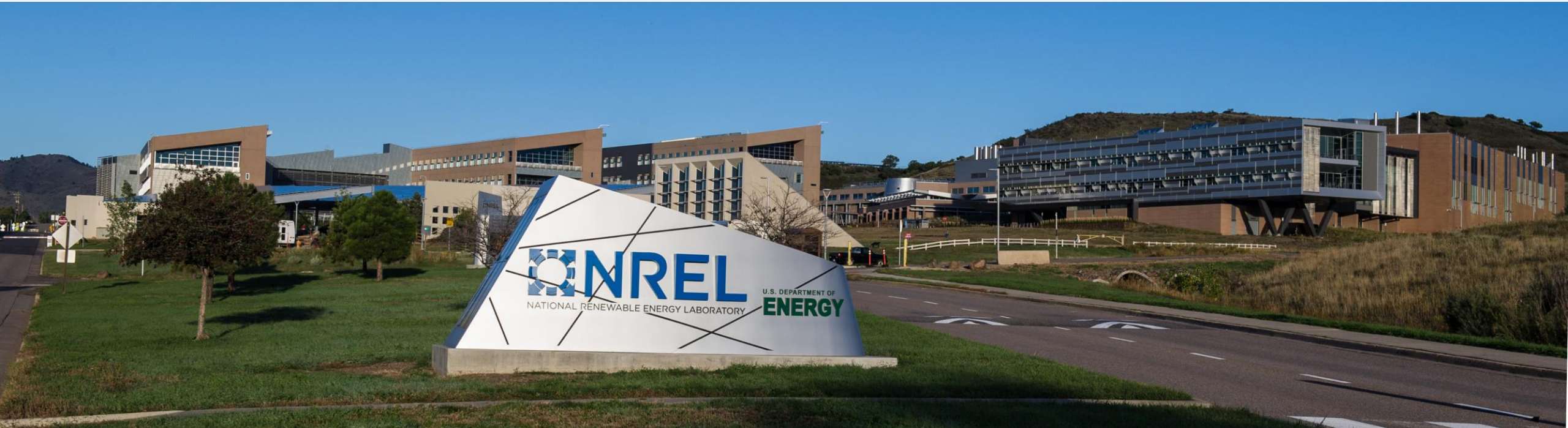
RTDS INTEGRATION FOR PHIL APPLICATIONS

Linear Amplifiers for High-fidelity Power Hardware-in-the-Loop

- Currently, NovaCor and GTFPGA + *GTSOC*.
- Clustered NovaCor chassis ~ 12 chassis
- SPS Linear Amplifiers 4 x 45 kW 3-phase PHIL
 - Commissioning process ongoing with SPS and NayakCorp.
 - PHIL use-cases in July-September 2023.
 - Focus: Power quality, stability issues with power electronics-based resources.
- Integrated multi-point PHIL with large-scale EMT simulations (tens of kVA up to 20 MVA).



THANKS



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