ARIES at its Best

Top 10 Research Impacts from FY20 – FY24

Summary: ARIES Top 10 R&D Impacts (FY20 – FY24)

ARIES is addressing three *energy system* technical challenges

Helping communities and utilities with new energy systems

- Fairbanks, AK moving from coal to wind and batteries
- Dispatchable hybrid system controls for energy markets with FlexPower
- Resilient, remote microgrid operation in Cordova, AK

Proving and standardizing cybersecurity and power electronic technologies

- Validated grid-forming inverters for grid stability
- UNIFI Consortium developing grid-forming inverters standards
- Evaluation of cybersecurity authentication protocols
- Validation of silicon-carbide wide-bandgap converters

Demonstrating the capabilities of integrated energy systems for efficiency and reliability

- Black Start of a 100% renewable MW generation system
- Bringing nuclear and renewable generation together with hybridized controls
- Transportation and building hub digital twin for cost and resiliency optimization

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ARIES Supports Fairbank's Transition from Coal to Wind Generation

- ARIES was used to create a future Fairbanks community energy system to increase confidence for energy transition decisions and deployment
- Potential to scale and customize for other communities with Clean Energy to Communities (C2C).

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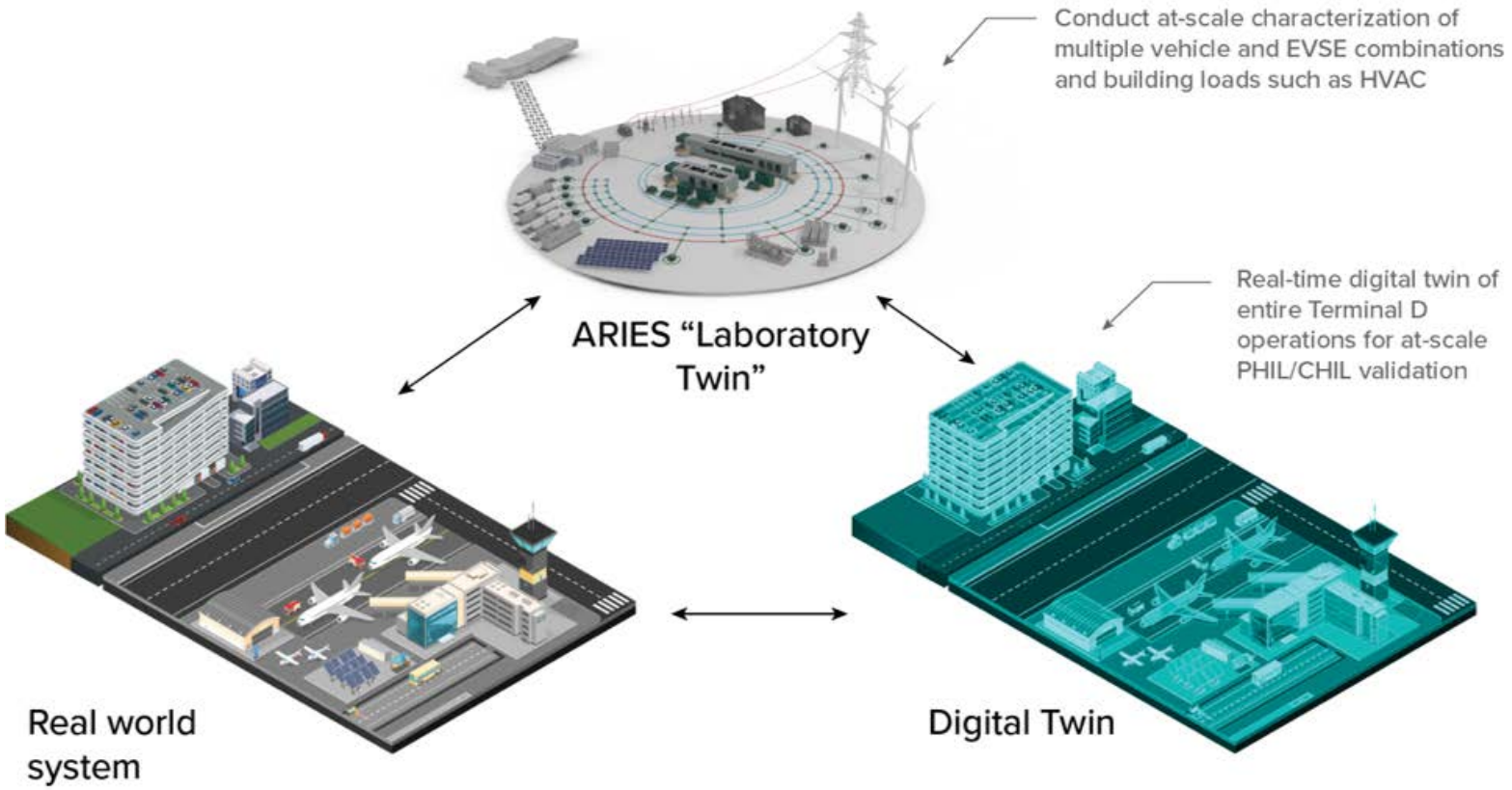
REGI



ARIES Supports DFW's 2030 Zero Emissions Goal

- ARIES was used as a digital twin of the airport to optimize building efficiency and demand flexibility system controls
- Lessons learned can be applied to various climates, building types, utility rates, etc.

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VTO/BTO

100% 2 MW Renewable Energy System ARIES Black Start Demo

- With solar, wind, and battery storage, researchers built a stable microgrid with 100% renewable energy
- System applied grid-forming inverters and customized controls
- Approach can be scaled and customized for other renewable energy systems.

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WETO/SETO/REGI

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Validated Flexible PV-Wind-Storage-Hybrid Controls with ARIES

- Demonstrated the benefits of this hybrid system performance for regional grid reliability
- Established foundation for publicly available, validated hybridization and control architectures.

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GMLC/WETO/HFTO/WPTO/OE

Photo credit: Tara Brannon Photography

ARIES Supports Deployment of RADIANCE–a Self-Healing Microgrid System for Cordova, Alaska

- ARIES was used as a microgrid digital twin to design and validate a system-management approach tailored to Cordova's environment, customers, and loads
- Success and lessons of RADIANCE offer a promising foundation for other remote and islanded communities to deploy resilient microgrids.

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ARIES Leveraged to Inform IEEE Standards for Grid-Forming Inverters

- Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium release first governing document for grid-forming inverters (GFM) principles and specifications
- Consortium used ARIES to demo 1MW GFM inverters including a synchronous generator, to validate performance of the inverters from multiple vendors in various operating modes to inform standards.

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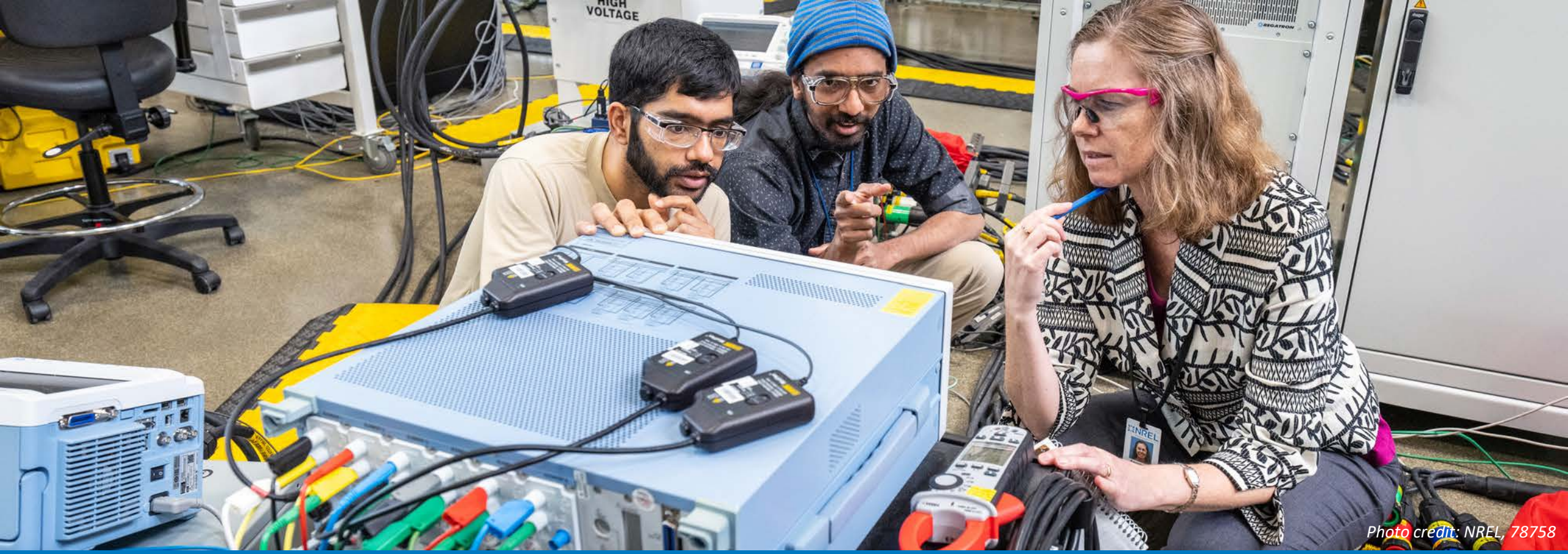

Photo credit: NREL, 78758

Validating Grid-forming Inverters in Realistic Systems with ARIES

- Validated grid-forming fuel cell inverter which demonstrated how the system could support microgrid resiliency
- Grid-forming inverter validated technology is needed for grid stability with high numbers of inverter-based resources (e.g., wind and solar)
- Technology can be replicated and scaled for other systems.

Combined SuperLab Demonstrates Unique Hybrid Power Plant

- Proved renewables and nuclear hybridization potential for increasing electrical demands with the ARIES platform solar, electrolysis, and battery technologies and INL's nuclear reactor
- Connected to other national labs through ESnet to unlock DOE's research assets, cutting-edge technologies, and talented scientists with SuperLab 2.0.


Photo credit: NREL

Game-Changing Power Electronics Advances to Interconnect Distributed Energy Resources

- Applying ARIES medium-voltage research capabilities to accelerate deployment of silicon carbide wide-bandgap devices
- Provide increased abilities to manage the distribution system during disasters, emergencies or after system failures.

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ARIES Cyber Range Evaluates Cybersecurity Technologies

- NREL's Clean Energy Cybersecurity Accelerator™ (CECA) advances cyber innovation to defend modern, renewable energy technologies against high-priority cybersecurity risks to the energy sector
- ARIES Cyber Range assess novel technologies in a highly realistic simulation environment and evaluates against attacks that could paralyze power systems across the world.

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