SC NEXUS

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STRATEGIC INITIATIVES & OPERATIONS MANAGER
SC Nexus for Advanced Resilient Energy

SOUTH CAROLINA DEPT. OF COMMERCE LAUNCH TO LEGACY

SC NEXUS was established through the EDA's Tech Hubs Program to build a regional innovation ecosystem dedicated to advanced energy technologies

Why it was created

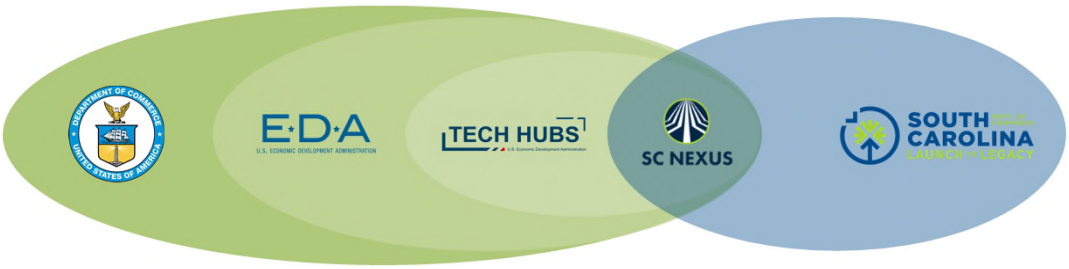
Strengthen U.S. economic and national security by scaling critical technologies.

What it does

Invests in regions to accelerate technology commercialization and deployment.

Why it matters

Enables regions to compete globally by building the systems needed for innovation.



We work to develop SC's advanced energy economy, facilitate collaboration, and leverage the state's manufacturing strength to bring innovation to market

SC Nexus
for Advanced Resilient Energy

One of 12 Tech Hubs across the nation to receive the EDA's implementation funds.

The **only** federally designated Tech Hub with a statewide footprint.

Develop energy solutions that strengthen national security and enhance competitiveness.

Test and refine technologies that drive advanced energy innovation across industries.

Deploy pathways to jobs, from entry-level to advanced, that support the energy workforce.

We support the deployment of advanced energy technologies across generation, transmission and distribution, and storage

Advanced Energy Technologies – Any innovation, infrastructure, manufacturing process, or operational capability that improves the production, delivery, distribution, storage, management, security, resilience, affordability, efficiency, or consumption of energy systems. These may include but are not limited to:

Generation: Technologies, infrastructure, and manufacturing capabilities related to the production, conversion, and supply of energy.

Transmission & Distribution: Infrastructure, hardware, software, and operational systems required to transport, integrate, manage, secure, and optimize the flow of electricity across the grid.

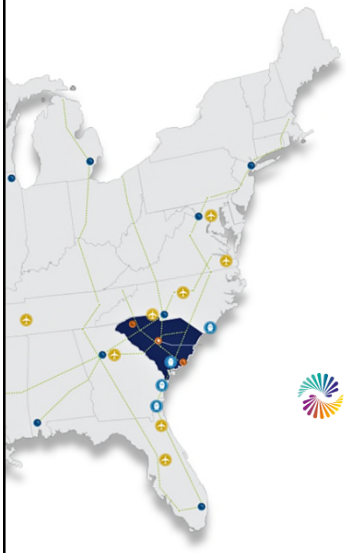
Energy Storage: Technologies, systems, and manufacturing capabilities that enable the storage and deployment of energy to improve grid reliability, resilience, and operational efficiency.

We support the deployment of advanced energy technologies across generation, transmission and distribution, and storage

Advanced Energy Technologies – Encompasses any innovation or manufacturing process that makes energy production, delivery, distribution, storage and consumption cleaner, more efficient, affordable, reliable, and resilient to disruptions. These may include but are not limited to:

- **Advanced Nuclear Technologies**
- **Distributed Energy Resources (DERs)**
- **Sustainable Power Generation**
- **Energy Storage Systems**
- **Smart Grids Technologies**

South Carolina is home to 300+ leading players across the advanced energy industry



Dominion Energy · DUKE ENERGY · santee cooper · mtu A Rolls-Royce solution · GE VERNOVA · SIEMENS · BOSCH · EATON · Schneider Electric · OTS CONDUCTOR · Westinghouse · amentum · FLUOR · BECHTEL · PHENOGY · KYOCERA · EnerSys · FENECON · Soteria · REDWOOD MATERIALS · Cirba Solutions · evac nothing to waste

SC NEXUS is continuing to scale and pursue funding opportunities

2023

AUG: Applied for designation by U.S. Economic Development Administration as a Regional Technology and Innovation Hub

OCT: SC NEXUS selected as one of 31 designated Tech Hubs.

2024

JULY: Awarded $45 million in federal funds for SC NEXUS component projects.

SEPT: Officially launched as a Division of the South Carolina Department of Commerce.

2025

Critical Testbed and Asset Development

Leveraged Funding / EDA Funding → $80,495,871 / $45,351,146 = **1.77**

For every $1 in EDA funding received, our testbeds leveraged an additional $1.77

SC energy ecosystem captured $2.9 B in investments and 2,000+ jobs announced.

2026

JAN: Federal approval of expansion, making SC NEXUS the first and only statewide designated Tech Hub.

FEB: Launch of eiX Venture Studio in collaboration with the South Carolina Research Authority and NextGEN.

Functions of SC NEXUS across South Carolina's Advanced Energy Sector

Program Management

Delivering SC NEXUS initiatives, including testbeds and projects, to advance technology validation, deployment, and industry adoption.

Ecosystem Development

Strengthening the advanced energy businesses, creating momentum and investment opportunities to further increase supply and demand.

Thought Leadership

Providing data-driven insight and strategic perspective to identify opportunities, anticipate risks, and guide ecosystem development.

Stakeholder Coordination

Connecting different advanced energy players, agencies, and institutions for operations, research, and funding.

Our Testbeds span the lifecycle of energy technologies, from generation and transmission, to storage

Carolina Institute for Battery Innovation (CIBI)

Battery and Energy Storage Innovation

- Grid-scale pilot manufacturing and testing before full commercialization
- Lowers R&D costs and technical risk for new products and processes
- Supports advanced manufacturing and supply-chain localization

Economic Development through Grid Emulation (EDGE)

Grid Reliability and Energy Systems Testing

- Real-world testing of grid-connected equipment and power systems
- Validates performance under stress, faults, and extreme conditions
- Helps improve reliability and reduce energy-related operational risk

Grid Enabled Cyber Operations Range (GECO)

Cybersecurity and Supply Chain Security

- Safe environment to test grid-connected and industrial technologies
- Identifies cyber and supply-chain vulnerabilities before deployment
- Strengthens operational security and customer confidence

Our projects empower innovators and entrepreneurs, allowing them to access our testbeds and source talented employees

Education & Workforce Center (EWC)

In partnership with the SC Technical College System, SC NEXUS provides funded support to award students with energy-focused scholarships and exposure opportunities.

16 PARTICIPATING COLLEGES ACROSS THE STATE

K-12 ENERGY FOCUS CURRICULUM FOR JOB READINESS

14,000+ ENERGY-REALTED JOBS IN SOUTH CAROLINA BY 2030

Entrepreneurship & Innovation eXchange (eiX)

eiX ignites innovation and entrepreneurship by connecting South Carolina's top talent, tools and tech to turn bold ideas into scalable ventures.

SCRA South Carolina Research Authority · FEDTECH · nextGEN Greenville Entrepreneur Network

ECONOMIC DEVELOPMET THROUGH GRID EMULATION

Sez Russcher, PhD
sez@clemson.edu
Distinguished Professor of Mechanical Engineering
Clemson University

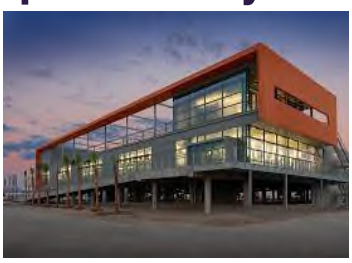
June 9th, 2026

CAMPUS UPDATE

Charleston Campus Today

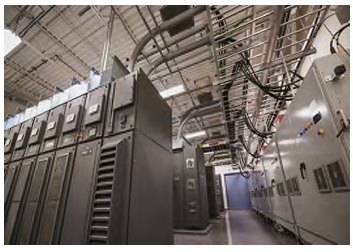
Education & Research

- **MS and PhD:** Computer Engineering, Computer Science, Electrical Engineering, Mechanical Engineering



Major Centers and Labs

- Zucker Family Graduate Education Center
- Dominion Energy Innovation Center – Wind Turbine Test Beds (7.5MW and 15MW) & Duke Energy eGRID
- Warren Lasch Conservation Center



Industry Engagement

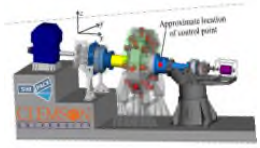
- **Energy Research and Commercial Testing:** GE Vernova, Siemens Gamesa, Duke Energy, FlexGen Power Systems, SMA Solar Technology, Yaskawa Solectria Solar, ORBIS, Dominon Energy, Eaton, TWMC

RESEARCH CAPABILITIES

Dominion Energy Innovation Center

- Duke Energy eGRID Center
  - 15 MW HIL Grid Simulator

- Simulation Capabilities
  - Hardware-in-the-Loop & Multibody



- Wind Turbine Drivetrain Testing Facility
  - 7.5 MW Test Bench

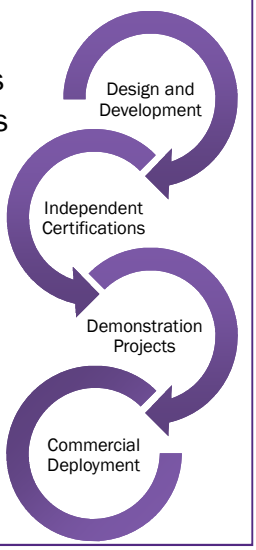
  - 15 MW Test Bench

Distinguishing experimental capabilities offering tremendous opportunities as well as long-term strategic challenges.

Duke Energy e-GRID grid emulation to accelerate development and deployment

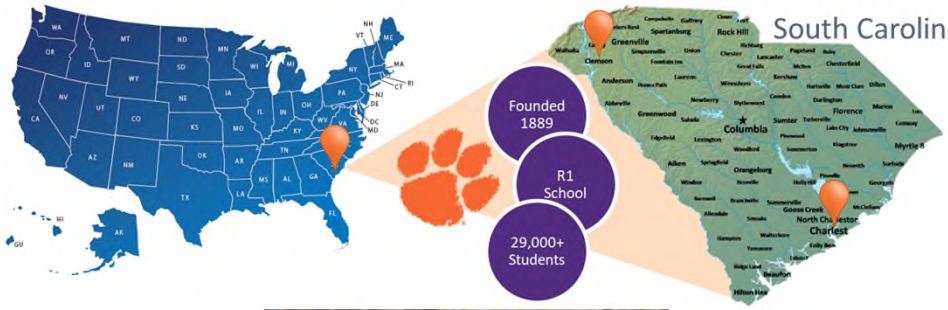
Duke Energy e-GRID houses a powerful grid emulator that mimics real-world circumstances – such as wide-area power disruption from natural disasters, cascading accidents, and cyber or physical attacks without real world risks.

The emulator can *test, certify and accelerate introduction of new technologies on to the distribution and transmission systems.*



HISTORICAL PERPSECTIVES

Clemson University in Charleston



CSX Transportation & Norfolk Southern

Rail Access

Energy Innovation Center

Zucker Family Graduate Education Center

Deep water access – Charleston bay

Dock Access (1,000 ton)

COMMERCIAL TESTING CAPABILITIES

Electromechanical Testing Capabilities

Electrical Testing

- Power Quality Test
- Voltage Ride Through (VRT) Test
- Fault Ride Through (FRT) Test
- Frequency Response Test
- Harmonic Testing
- Grid Code Compliance Test

Mechanical Testing

- Static and Extreme load testing
- Dynamic Load Testing and Vibration Analysis
- Failure Mode and Effects Analysis (FMEA)
- Fatigue and Durability Testing
- Gearbox Efficiency Testing
- Bearing Performance Testing

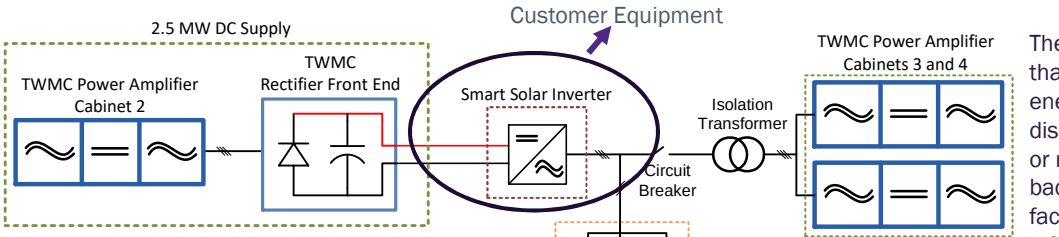
Thermal Testing

- Controlled temperature
- Controlled humidity

IEEE 519, IEEE 1453, IEEE 1547, IEEE 2800, IEEE 2030, UL 1741

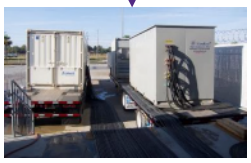
CURRENT CAPABILITIES

Case Study: Solar Inverter Testing



The PAUs act like the utility grid, delivering controlled voltage, frequency, and power.

The PAUs absorb that returned energy and either dissipate it safely or regenerate it back into the facility/grid infrastructure.

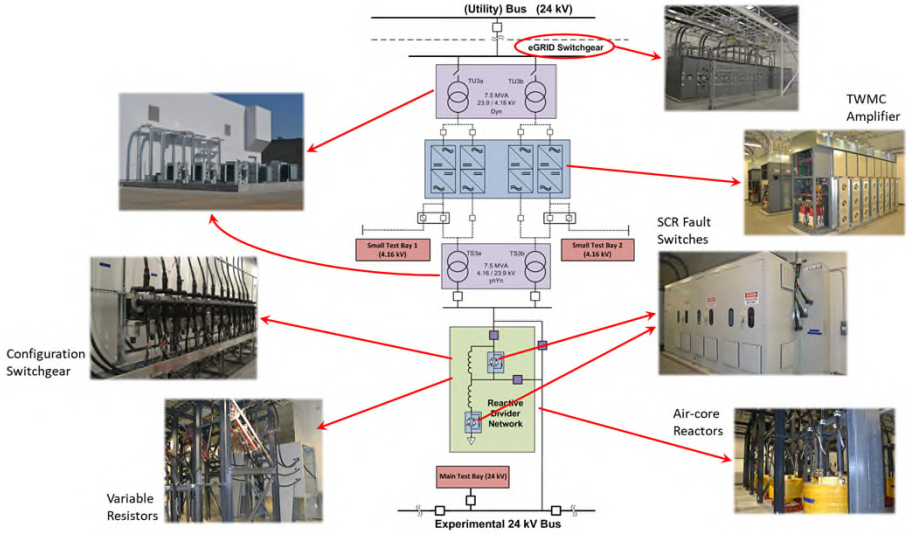


We have independently controllable quadrants of a programmable power system. Together they create a flexible synthetic grid where power flow direction, magnitude, and phase relationships can all be controlled dynamically.

- 1000 V class, 2+ MW, 4160 test bus
- UL 1741 SA-SB/IEEE 1547
- Fault ride-through, Frequency ride-through and Voltage ride-through

CURRENT COMMERCIAL TESTING CAPABILITIES

Components of Duke Energy e-GRID



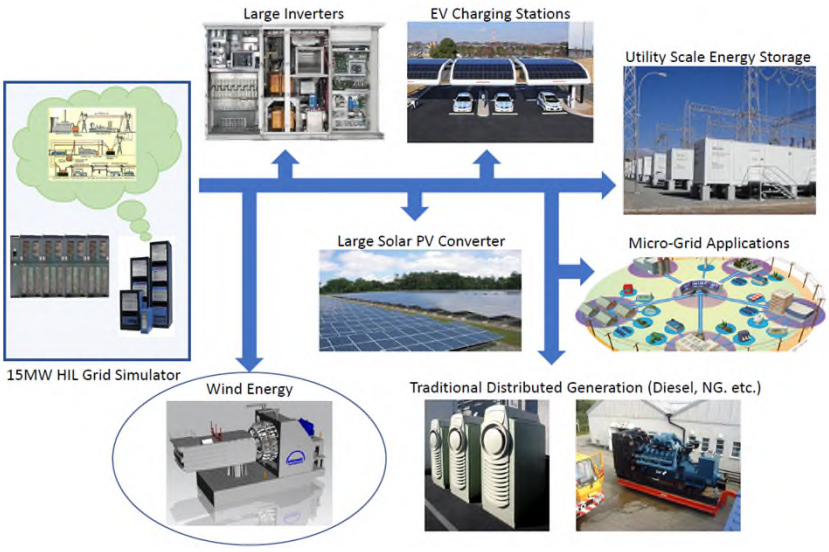
STRATEGIC OPPORTUNITIES

Active Research Areas & Test Contracts

- Renewable Energy – Solar, Wind, Tidal
  Testing methodologies, new technologies, standards development
- Microgrids –Multi-resource integration and standardized design and control
- Battery Energy Storage – Standards development and testing for charging and discharging
- Data Centers – Cooling systems, high-density power supplies, high-capacity backup systems, and advanced workload scheduling strategies
- Transmission level interconnection standards (IEEE P2800) – Inverter-based resources: wind, solar, battery, HVDC lite, STATCOMs
- Multi-Inverter Synchronization – Grid forming inverters for transmission and distribution
- High Power Electric Vehicles - Charging infrastructure & power electronics
- Advanced Energy Capture Systems - Heat recovery systems, gas resource extraction
- Small Modular Reactors (SMA) or Micro-Reactors
- Cybersecurity of the Grid (Savannah River National Laboratory)
- Hydrogen Energy and Storage

CURRENT RESEARCH CAPABILITIES

Dominion Energy Innovation Center

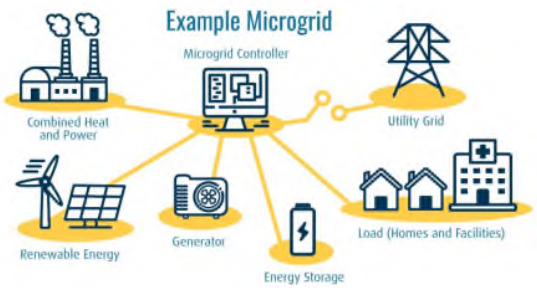


NEW INITIATIVES

Microgrids: Enhancing Grid Resilience and Reliability

Microgrids are localized energy systems that can independently (islanded mode) or in conjunction main power grid.

Microgrids can serve as a vital defense mechanis against the impacts of weather events, such as hurricanes in coastal regions, significantly reduci downtime for residents and businesses.



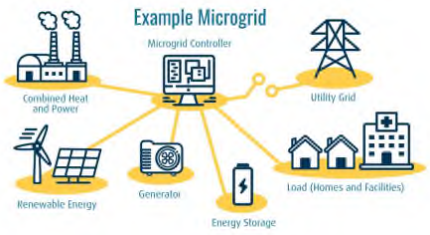
In addition to consistent electricity supply, microgrids can provide several grid support services, such as voltage and frequency regulation, peak shaving, load balancing, demand response, ancillary services, contributing to the stability and reliability of the larger electrical grid.

NEW INITIATIVES

Barriers to Microgrid Implementation

Microgrids involve complex system integration of diverse assets (e.g., generation, energy storage devices, controllers, and protection systems).

Achieving a seamless transition between the islanded and grid-connected modes requires complex controls and synchronization for stable voltage and frequency regulation.

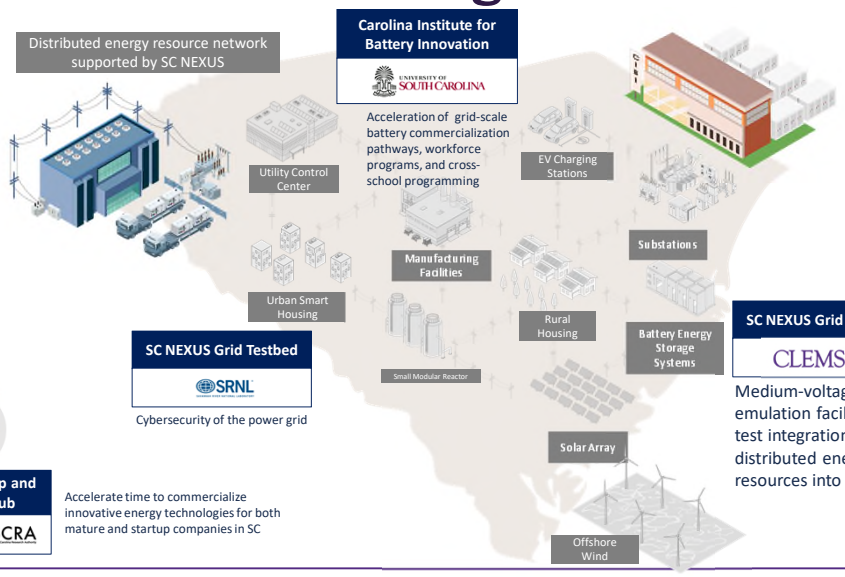


The robust operation of microgrids is heavily dependent upon control, load management, resilient operations, protection, grid-support functionalities, cyber security, islanding and grid-connected operations, and optimal interaction with the associated grid.

The microgrid implementation often experiences technical hurdles and commissioning delays, which can extend to years, reducing financial viability and project feasibility.

RESILIENCE THROUGH DISTRIBUTED ENERGY RESOURCES

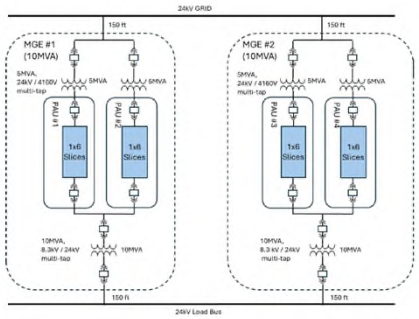
SC NEXUS to become global tech leader



RESEARCH CAPABILITIES

Dominion Energy Innovation Center

System Parameter	SC NEXUS - EDGE Equipment
Rated Power	20 MVA
AC Output Voltage	0-24 kV rms ±5%
Design Topology	Power Transformer with Tabs
DC Output Voltage	0–6 kV DC ±5%(up to 12kV)
HVRT	140% of Rated Voltage
Operation Ambient Temperature	-25 to 45 °C
Noise Level	55 dB at 10 m
Regenerative Operation	4Q AC and 2Q DC mode
Control Modes	V, I, load emulation, impedance control
Output Frequency Range	0–65 Hz capability
Harmonic Injection	Per IEEE 519-2014 and IEC 61000-4-13
Subharmonic Injection	1 to 55 Hz
Control Loop Speed	12 kHz
Phase Shift	180° < 10 ms
Voltage Slew Rate	20000 kV/s
LVRT/ZVRT	Asymmetrical 0 to 0% per Phase
THD	<2%
Equivalent Impedance	1–500 MVA
Impedance Control Bandwidth	50 and 60 Hz
Accuracy V, I	<1%



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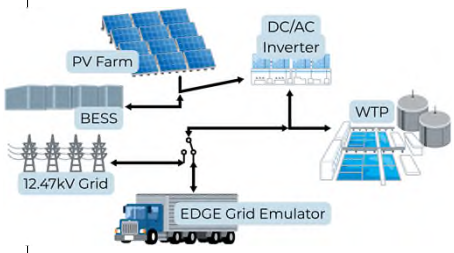

NEW INITIATIVES

Mobile Grid Emulation and Full-Scale Microgrid Testing

Clemson University's unique mobile grid emulators, made available through SC NEXUS, can alleviate commissioning challenges, reducing costs and improving the economic efficiency of microgrid planning, design, and execution, operation.

Example 1) EDGE can enable dynamic transition testing between grid-connected and islanded operating modes, verifying synchronization, voltage recovery, frequency stability, power-sharing accuracy, and seamless reconnection under transient fault and disturbance conditions commonly encountered in southeastern utility networks.

Example 2) EDGE can perform field validation of protection and control schemes, including relay coordination, anti-islanding functionality, fault ride-through performance, adaptive protection settings, and inverter-based resource (IBR) interactions without risking the real life utility system.

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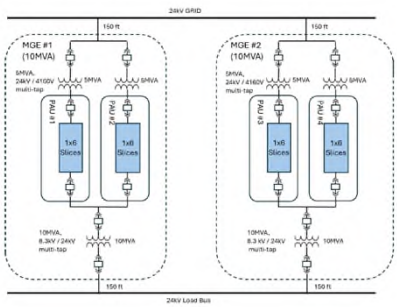
Example 3) EDGE can emulate weak-grid and extreme-event conditions representative of hurricane-prone coastal systems, allowing operators to evaluate microgrid resiliency, load shedding strategies, energy management systems (EMS), and restoration sequences under realistic operating scenarios before commercial operation begins.

Example 4) EDGE can reduce microgrid commissioning timelines by enabling pre-certification and interoperability testing of generators, battery energy storage systems (BESS), solar PV inverters, and supervisory controllers at the installation site, minimizing integration errors and reducing costly rework during startup and commissioning.

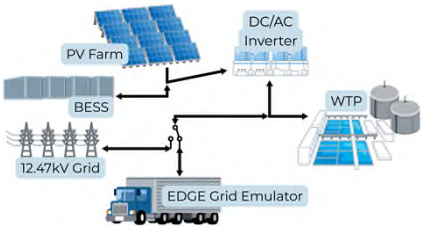


NEW FUNDING OPPORTUNITIES – AN EXAMPLE OF A RECENT PROPOSAL SUBMITTED TO EDA

Disaster Resilience for Economic Advancement through Microgrids: DREAM Coalition in South Carolina

If funded, the Coalition will be a statewide initiative to transform South Carolina's energy sector so that communities become robust, competitive, and attractive environments for investment, surpassing their pre-disaster economic conditions.

DREAM Coalition's goal is to accelerate and de-risk the deployment of *microgrids* in disaster-impacted communities.



The Coalition aims to

- Establish a state-of-the-art Microgrid Knowledge Center,
- Provide funding for feasibility studies,
- Subsidize the fees for using the EDGE equipment for smaller utilities,
- Initiate new training workforce development programs on microgrids and
- Construct two operational testbeds

Interested in Microgrids?

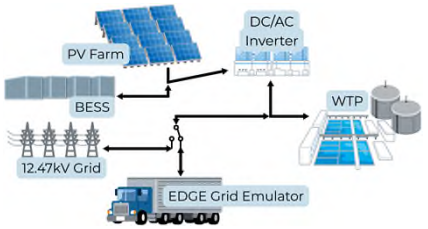
Whether you represent a small utility, electric co-op, municipality, or industry partner — we want to connect.

Contact:
Sez Russcher, PhD
Distinguished Professor, Mechanical Engineering @ Clemson University
sez@clemson.edu

NEW OPPORTUNITIES – AN EXAMPLE

Other opportunities we are actively pursuing to secure federal funding.

- **Test Grants to utilize EDGE Mobile Grid Emulators (SC NEXUS)**
  Clemson's nationally unique emulators de-risk microgrid deployment and make testing financially feasible for smaller project developers, enabling confident private investment.
- **Technical Assistance Program (TAP) Feasibility Grants**
  If funded, 16 preliminary engineering grants remove the upfront cost barrier for small utilities and municipalities, moving projects from concept to implementation-ready.
- **Workforce Development Program (WDP)**
  SCTCS trains the specialized electricians and engineering technicians SC's microgrid industry currently lacks, keeping labor supply pace with growing demand.



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There are many other opportunities that we can pursue together.

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