Leading the Transformation to Zero-Carbon Economy and Society

An Update to DAB of CECS

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Overview

Main funding sources:

- UCF Academic Excellence Funds
  - $3M for R1 microgrid and digital twins
  - $1M for faculty hires
  - $2M for startups, etc.
- Duke Energy
  - $2M from Florida Vision Funds
  - $2+M from Duke Energy

Members:

- Research teams: RISES & CATER
- Units: CECS, CREOL, COS, CCIE, SMST, FCI, UCF Facilities and Safety
- External partners: Duke Energy, Siemens, Siemens Energy, Mitsubishi, and Low Carbon Research Initiative

R1 Microgrid and Digital Twins

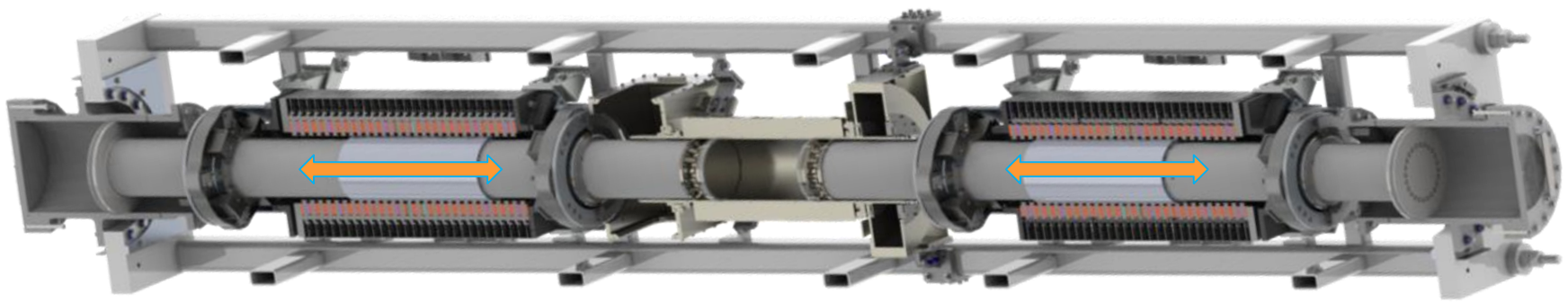
Resilient Zero-Emission Microgrid

- **Research Building I,** an interdisciplinary and experimental research
- Critical experiments require reliable power supply for the building
- Florida has an annual hurricane season
- Integration of roof-top solar generation
- Further hardening through on-site, zero-emission generation
- Separate test loop for grid-related research

Assets

- Existing
  - Two 250KW diesel backup generators
  - One 40KWh Flow Battery
- New assets
  - Two 240KW linear generators
  - 150KW rooftop PV arrays
  - 500kW/950kWh fact-response battery and inverter control
  - Microgrid controller and switch gears
  - Level-3 chargers
  - Microgrid controller for the test loop
- Test loop
  - 30KW power amplifier
  - 24KW regenerative load (expandable to 50KW)
  - Opal-RT hardware-in-the-loop (HIL) test system
  - Test equipment **(new)**

Non-Combustion Linear Generator



Video can be viewed at http://mainspringenergy.com/technology/

Power electronics and software enable simplicity of design and precision control

Low LCOE
High efficiency, low capital and maintenance costs

Low Emissions
Near-zero NOx, low CO_2 emissions

Dispatchable
Load tracking, fast on/off, black start, and island capable

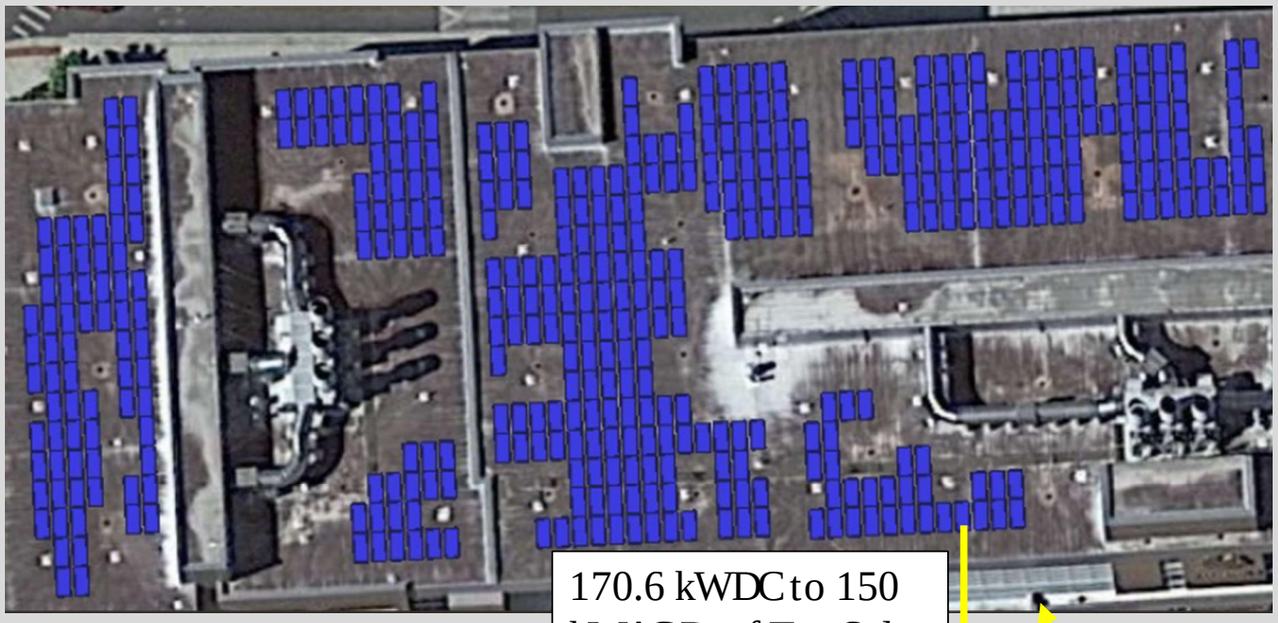
Fuel Flexible
Dynamic fuel switching capability

Starting point: blended fuel of 30% hydrogen and 70% natural gas
5-year test period: understand and integrate this and other technologies
Future goal: 100% green fuel

Aerial View

Generator Non-Reg. solution w/ Solar and Battery sources (Microgrid – MG)

Research One Bldg.



170.6 kWDC to 150 kWAC Roof Top Solar

To Load

Paralleling Switchgear

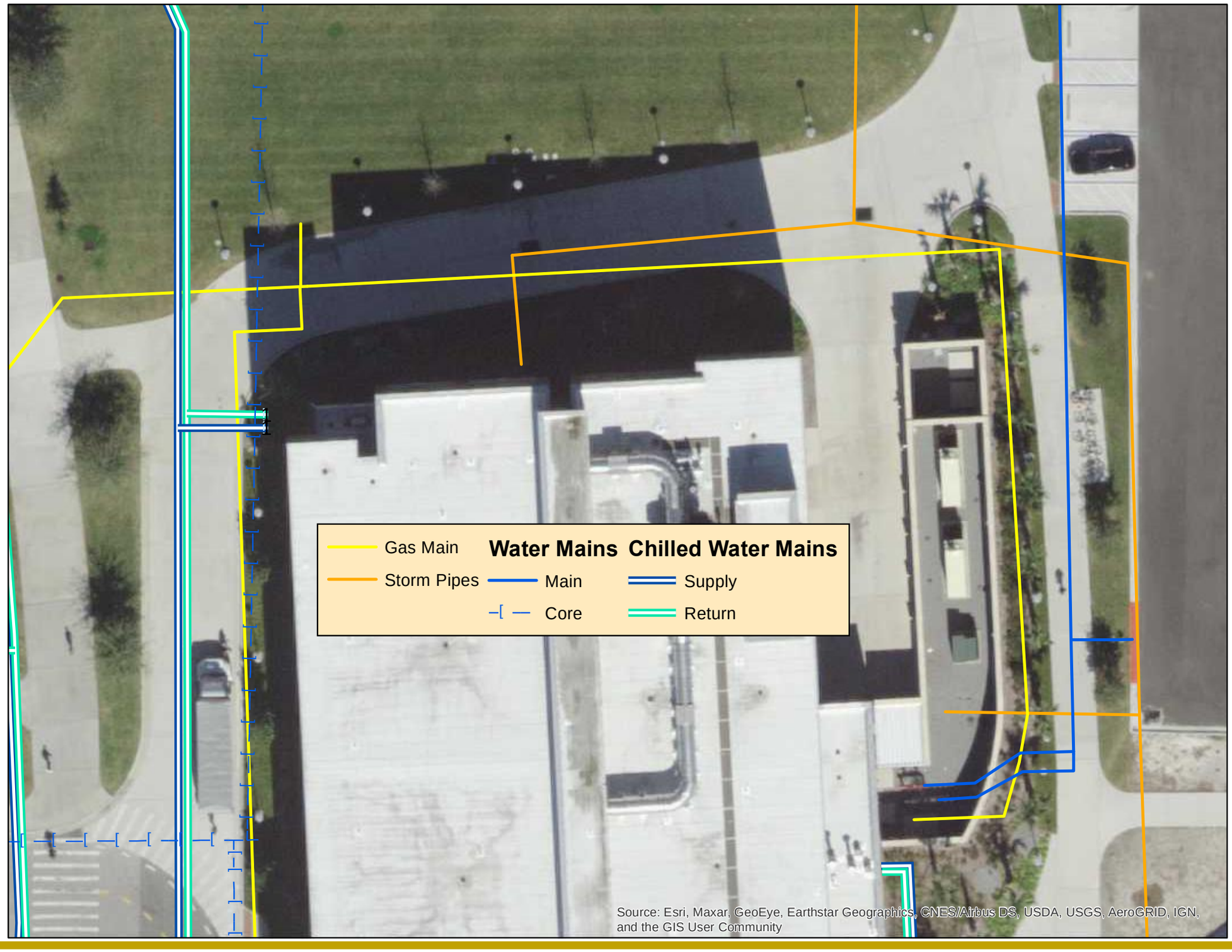
2 x 240kW Linear Generators

Main SG

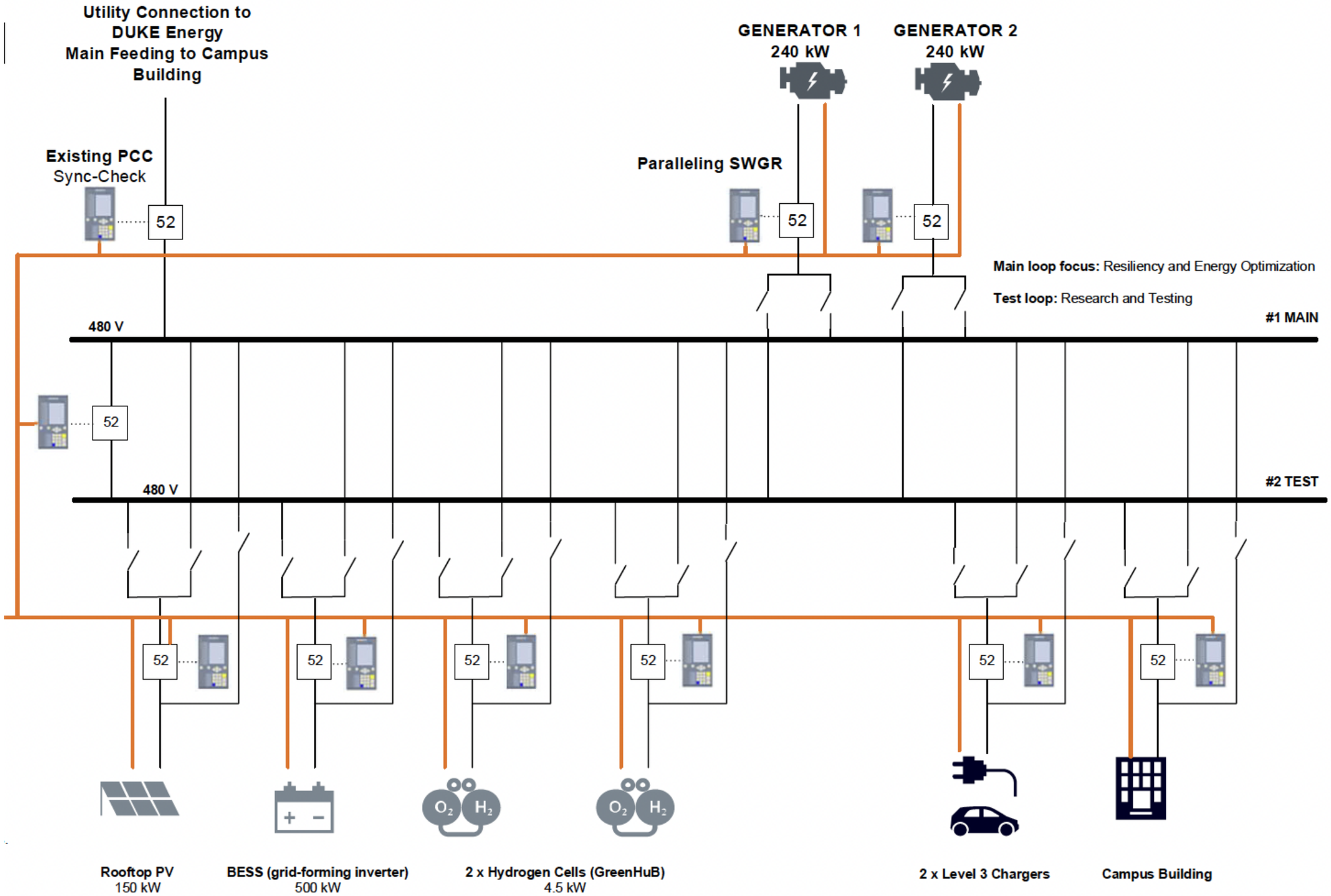
500kW Battery

Relocate Transformer

Physical Location



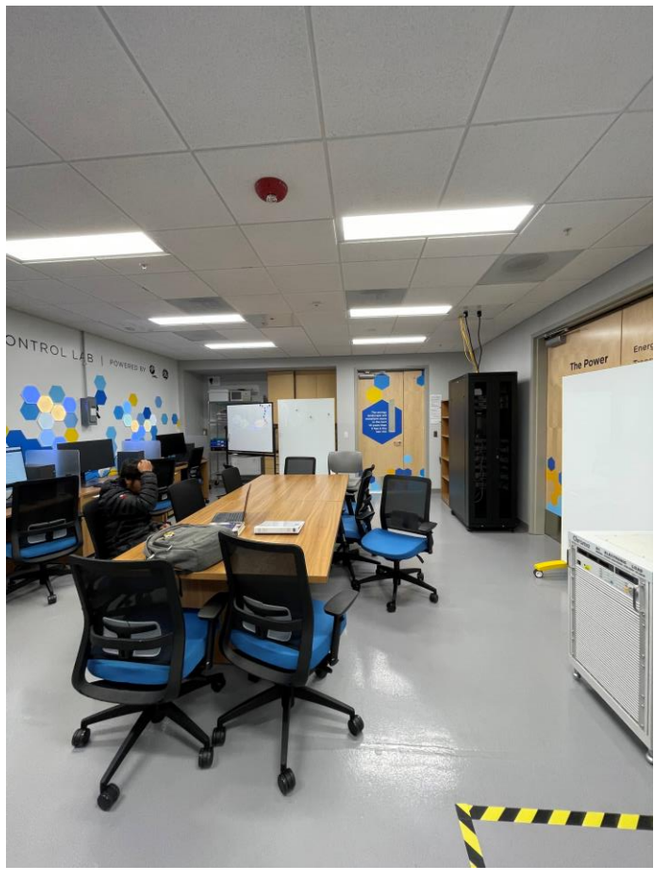
One-Line Diagram

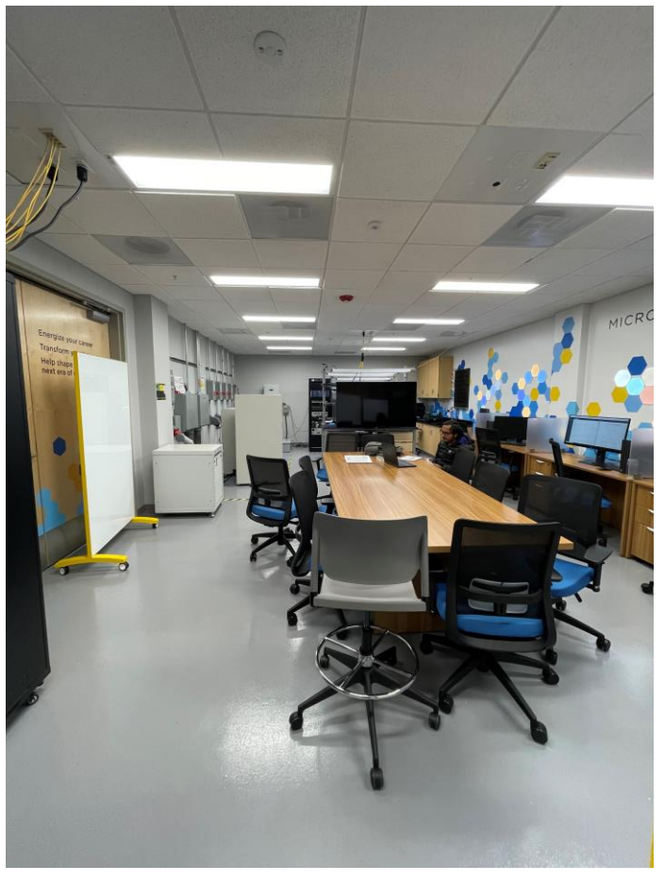


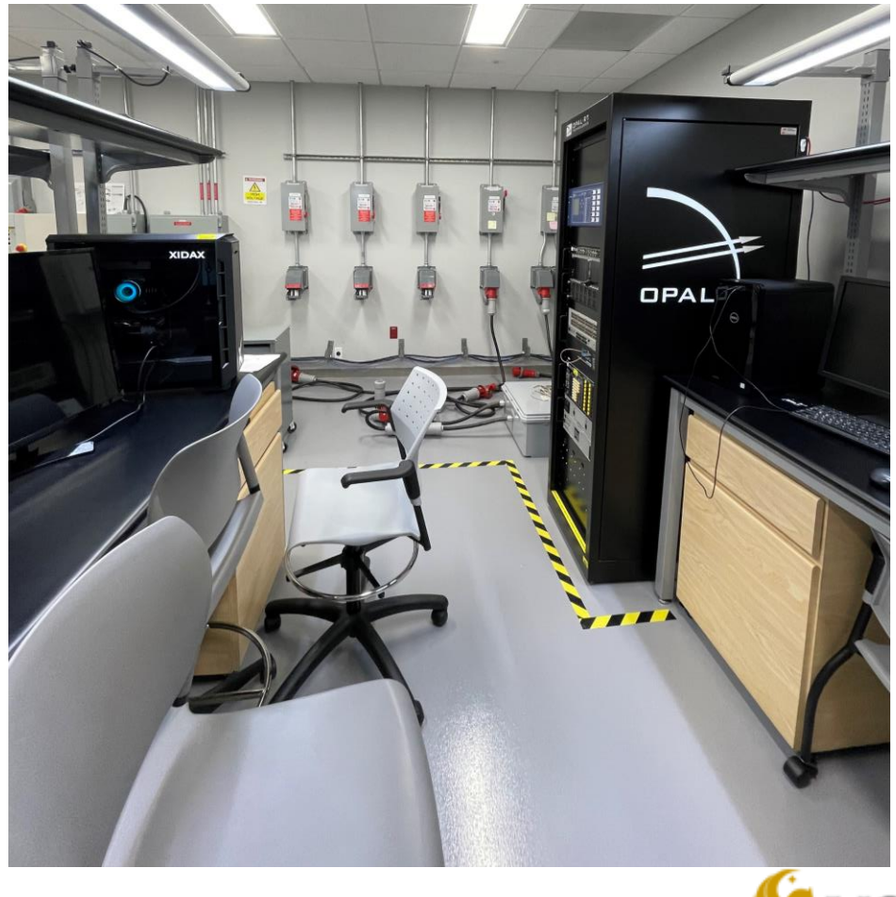
R1 Test Loop & Microgrid Control Laboratory

Main asset

- GE ADMS and EMS
- 30KW power amplifier
- 24KW regenerative load (expandable to 50KW)
- Opal-RT hardware-in-the-loop (HIL) test system
- Microgrid controller (to be installed)







R1 Digital Twins

The digital twins for real-time monitoring, optimization, control, and operation: one for R1 Building, and another for R1 Microgrid.

Intelligent Infrastructure Technologies:

- System of systems
- Data analytics, AI, and intelligent models
- Real-time optimization
- Knowledge automation and predictive maintenance

Benefits

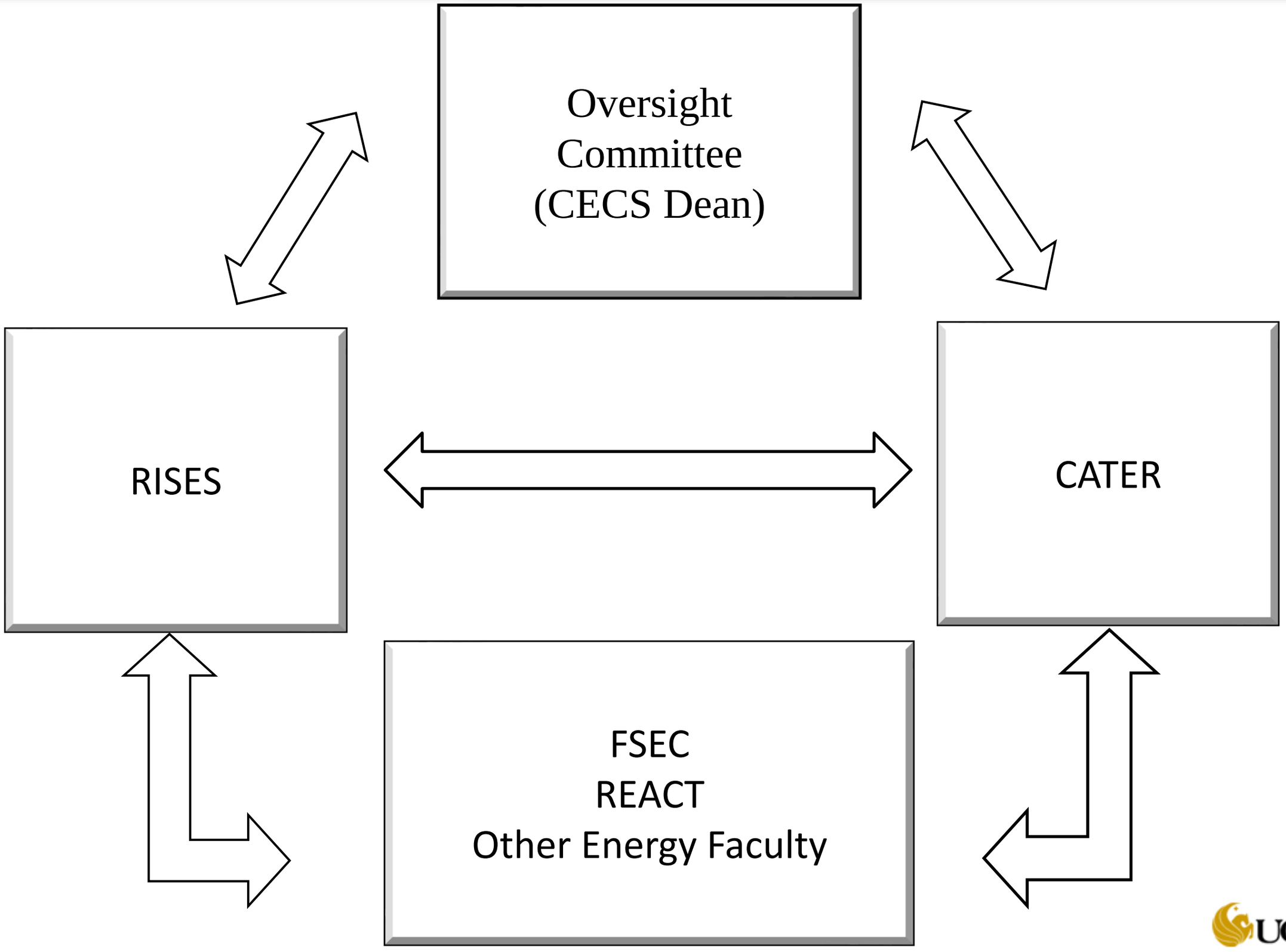
- **Zero emission and cost savings**: Linear generators which use a non-combustion reaction of air and fuel (gas or hydrogen) to move magnets back and forth through copper coils, generating an electric current. Little CO2 released, and zero NOx. More efficient without the separation of primary mover and electricity generator.
- **Sustainability:** Integration of renewables and storage technologies. Blended fuel reduces CO2 generation. UCF's new Energy Roadmap/Transition Plan to decarbonize its energy mix.
- **Resilience**: To control and optimize a diverse set of generation/storage assets with respect to real-time energy demands
- **Smart community**: Two integrated digital twins, one on the grid, and other on grid-interactive building
- **Education**: A living lab for students.
- **Research**: smart grid, decarbonization, cyber security addressing challenges in information technology, operational technology, control technology, and their integration; …
- **Partnership:** University-industry collaborations.

Implementation and Oversight

Microgrid Timeline (18 months)

Hiring Timelines (3.5 years):

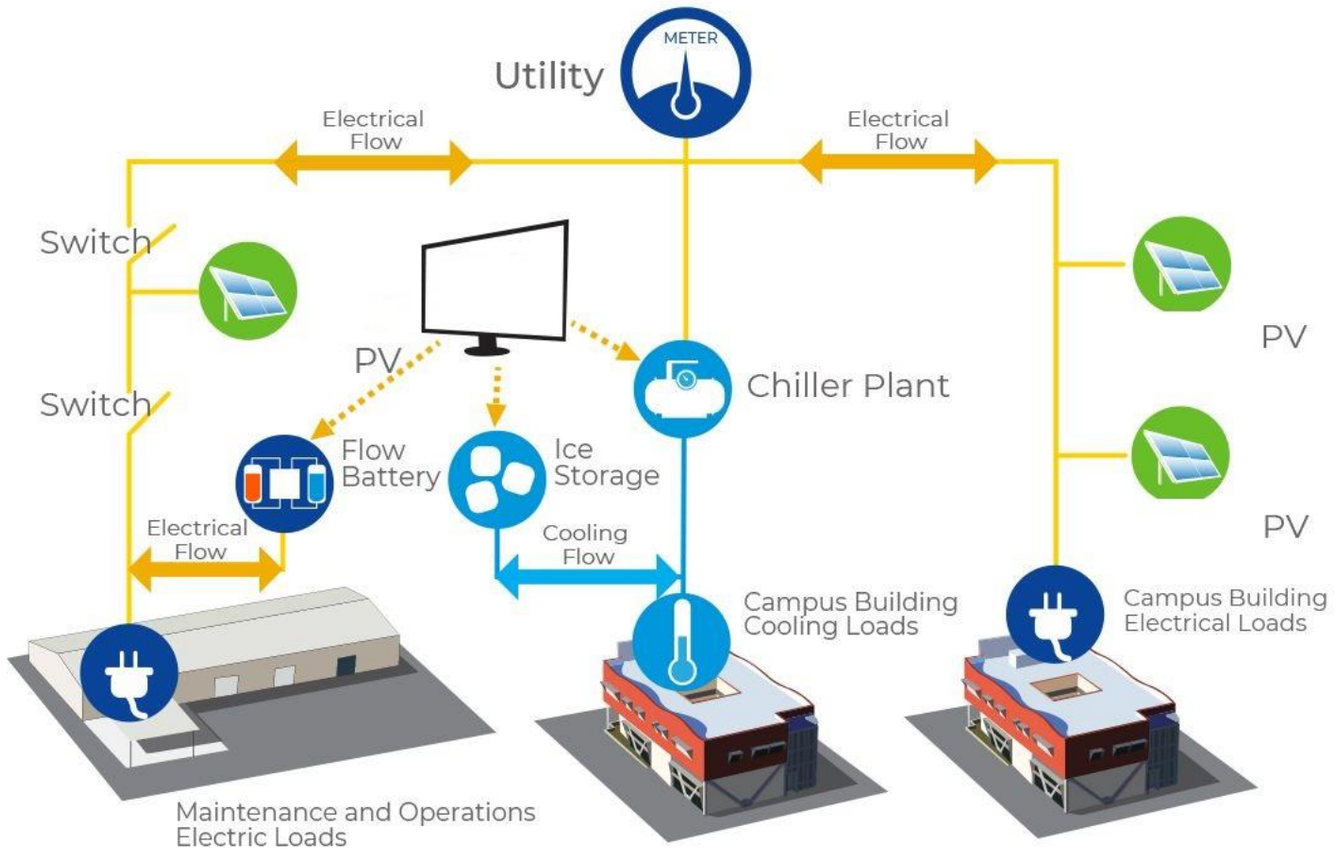
Faculty numbers	Home Colleges	Targeted Areas
1 & 2	FCI, CECS/COS	energy storage, non-combustion reaction, decarbonization
3 & 4	CECS	data driven optimization, control, and machine learning for energy systems
5 & 6	COS/CECS	data science, physics-based artificial intelligence
7 & 8	SMST	digital twin
9 & 10	CECS	aviation fuel and propulsion


Oversight Committee (CECS Dean)
RISES
CATER
FSEC
REACT
Other Energy Faculty

Collaborative Opportunities

Zero-Emission, Zero-Carbon, Networked Microgrids

UCF campuses will evolve into networks of zero-emission (and zero-carbon) microgrids, achieving efficiency and resilience at the grid-edge. R1 microgrid is a starting point.



Topics: hydrogen research, storage technologies, uninterruptable microgrids, resilient operation

Green Campus & Society

Focus and impact:

- Hydrogen-based power generation and distribution
- Energy storage
- Green industries:
  - power generation
  - aviation
  - transportation
- Decarbonization.

Q&A