Leading the Transformation to Zero-Emission Economy and Society

A Resilient Microgrid with Zero-Emission Energy Generation, Renewables, and Digital Twins

To

President Cartwright's Strategic Investment Program
Academic Excellence Fund

Participating Centers/Cluster/Colleges/Unit: RISES, FSEC, COS, CECS, CREOL, CCIE, UCF Facilities & Safety

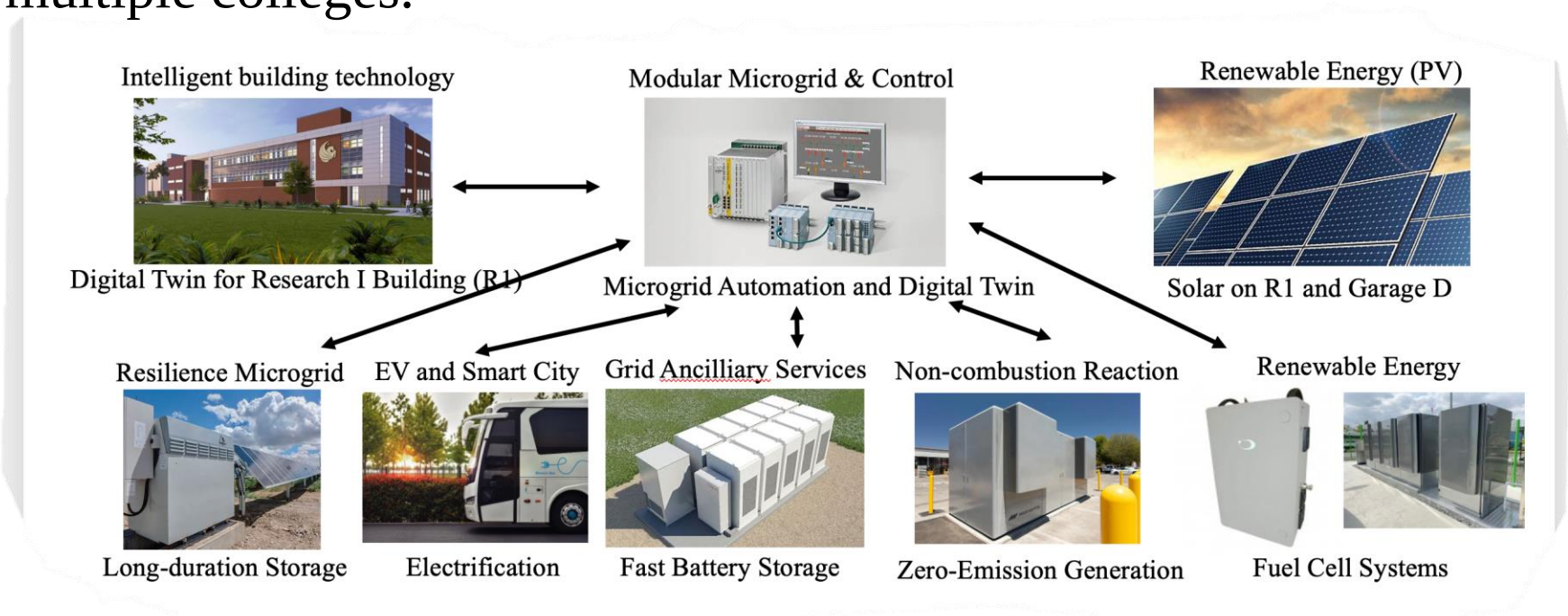
Internal Sponsoring Entities: UCF Facilities & Safety, CECS, COS, RISES, IST

External Sponsoring Entities: Duke Energy, Siemens

UCF

Proposed Microgrid

The proposed microgrid ensures uninterrupted power for Research I Building (even during major hurricanes). It has a separate test loop to enable world-class R&D in the areas described below. And, it also serves a living lab for our educational programs across multiple colleges.



Areas: sustainable energy systems, renewables and zero emission technologies, electrification of industries intelligent buildings and cities, cyber-physical security of critical infrastructure, data analytics and artificial intelligence for smart communities, real-time monitoring/visualization for automation and decision making (digital twins), economics and public policy of net-zero society.

Outcomes

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- The new microgrid makes our Research I Building operates robustly uninterrupted even during high-category hurricanes and major power outages, which immediately robustifies UCF research portfolios across the board

- The microgrid will has a testing loop that supports experimental and demonstration activities in smart grid, smart building technologies, energy storage technologies, connected community technologies, and decarbonization techniques, which elevates and expands UCF's energy systems research

- Strategic hires to fill gaps between multiple research teams (RISES, IST, CECS, COS/REACT)

Innovations of the Proposed Microgrid

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

Resilience: 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

Critical infrastructure protection: Advanced tools and a utility-grade testbed on cybersecurity and cyber-physical security to address challenges in information technology, operational technology, control technology, and their integration.

UCF

Impact

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- Through campus-wide collaboratives such as the proposed, UCF is moving to decarbonize its energy mix as outlined in the new Energy Roadmap/Transition Plan to be released in 2022.

- By adopting a network of microgrids, UCF can be a national leader in achieving the goals of resilience and sustainability.

- Annual cost saving of $400,000 for energy generated. The battery storage in the microgrid enables peak shaving and other cost saving and safety mechanisms for UCF, while operational cost and risks will be taken care of by our partners.

- Increase research and educational collaborations through collaborative hiring, and build collaborative research teams.

Overview of Budget: Part I --- Infrastructure

- Design and implementation of R1 microgrid (Nonrecurring: $3.96M from UCF central, $1.2M from UCF facility, and $2M from Duke Energy)

R1 Microgrid	**Subtotal**
Two near-zero-emission 240kW linear generators	2
R1 rooftop 150KW PV arrays	0.6
500kW/950kWh fact-response battery and inverter control	0.84
Microgrid controller and switch gears	1.2
Level-3 chargers	0.06
Site preparation (natural gas and hydrogen) and personnel	1.2
Subtotal	**5.90**

- Digital twins for R1 building and microgrid (Nonrecurring: $0.25M from UCF Central, and $0.25M from Siemens)

Digital Twins for R1 and Its Microgrid	**Subtotal**
Software	0.25
Servers and monitors	0.05
Personnel to implement digital twins	0.2
Subtotal	**0.5**

Financial Impact: *According to an independent assessment by TLC Engineering Solutions, the PV and linear generators adds to the energy generation by UCF, which translates into $400,000/y energy consumption saving for UCF and reduce the Greenhouse Gas (GHG) emissions on UCF's main campus by almost 4%, avoiding 1,800 MTCOE (metric tonnes of carbon dioxide equivalent) of GHG emissions into the atmosphere. The battery pack provides additional savings through peak shaving and load shifting.*

Overview of Budget: Part II --- Research Equipment & Hiring

• Research equipment to be added in R1 microgrid (Nonrecurring: $0.38M from UCF Central, and $0.38M from sponsoring units within UCF)

Research Equipment	Subtotal
Hydrogen fuel cells	0.15
Grid-transportation simulator	0.05
EV (bus)	0.1
PV panel test system	0.01
Autonomous inspection systems	0.25
Research pad upgrade and instrumentation	0.2
Digital twin research	
Subtotal	**0.76**

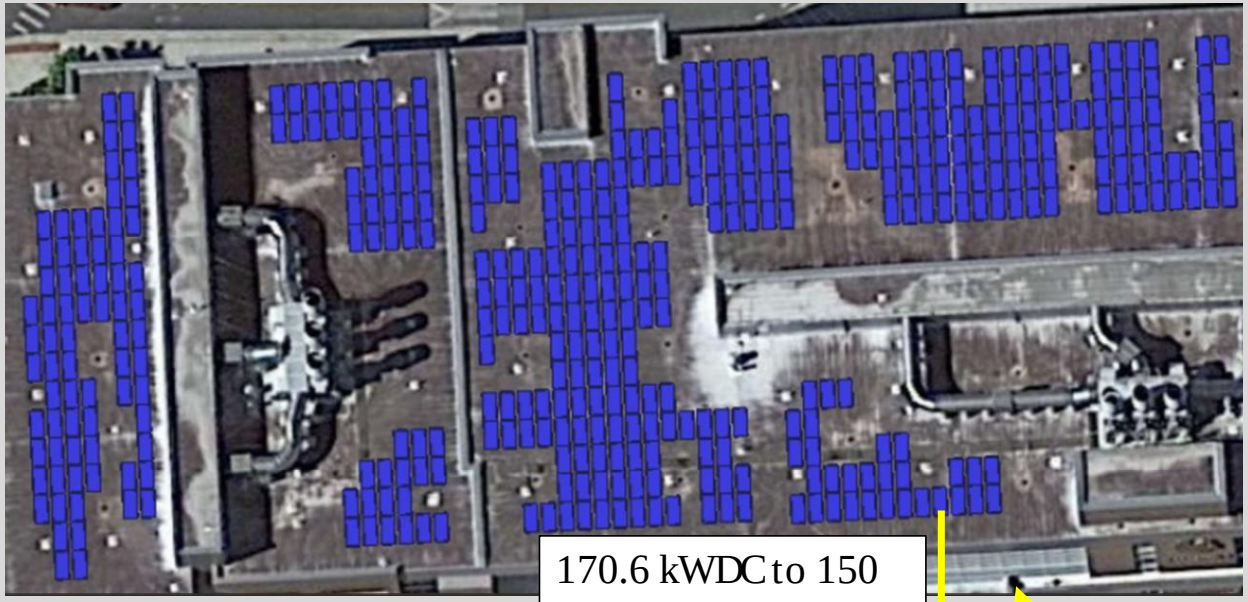
• 8 faculty members (25% assistant professors, 50% associate professors, and 25% full professors): 4 new lines paid by UCF Central, and 4 existing lines paid by colleges/units.

[1] GreenHub 2 - 5000 (fuelcellstore.com), with $60K estimated cost of fuel line installation. Utility-scale system: Leading Fuel Cell & Microgrid Solutions Provider | Bloom Energy
[2] 2021 EV Charging Stations Cost | Install Level 2 or Tesla (homeguide.com)

Pictorial Illustration of R1 Microgrid

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

Research One Bldg.



Paralleling Switchgear

2 x 240kW Linear Generators

170.6 kWDC to 150 kWAC Roof Top Solar

To Load

Main SG

500kW Battery

Relocate Transformer

Contacts

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Xin Li, Chair of Mathematics Dept, COS (College of Sciences)

Michael Georgiopoulos, Dean of CECS (College of Engineering and Computer Science)

Acknowledgements

Match providers:
- Colleges: CECS, COS
- Centers/Institutes/Clusters: RISES
- External Entities: Duke Energy Sustainable Solutions, Siemens

External/independent evaluator of impact: TLC Engineering Solutions (the company hired to develop UCF Energy Transition/Roadmap) and GreenerU (hired as a consultant for UCF Sustainability Plan)