



UNIVERSITY OF
SOUTH FLORIDA
COLLEGE OF ENGINEERING

USF's Power Program: R&D and Workforce Training

Lingling Fan

February 1st, 2025

Power and Energy Forum

**Chair:
Chris Ferekides**



Electrical
engineering



**Undergraduate
program director:
Ismail Uysal**

Wireless &
Microwave
Information
(WAMI)

**Power &
Energy**

Control &
Mechatronics

Bio

Nano

Communication

Security, CPS



Lingling Fan



Zhixin Miao



Mia Naeini



Yasin Yilmez

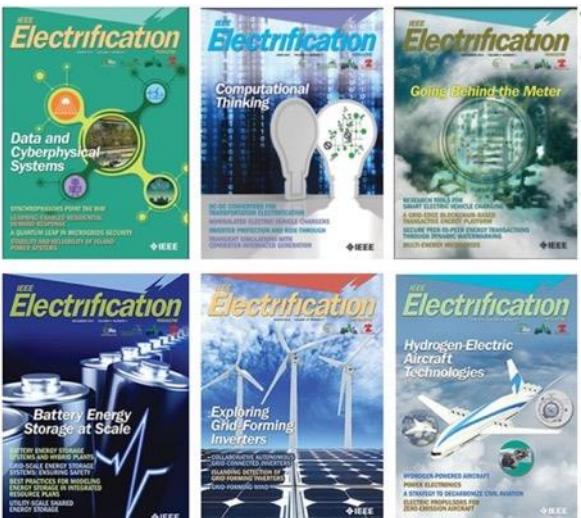
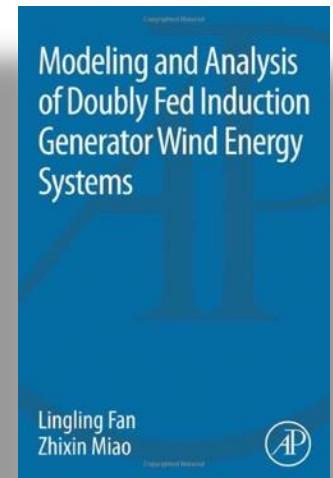
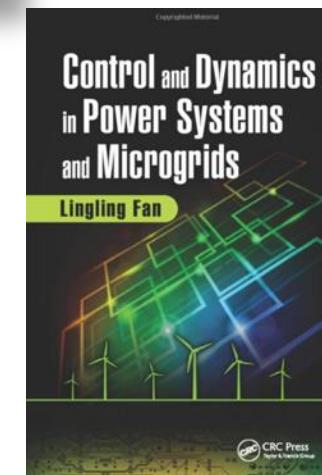
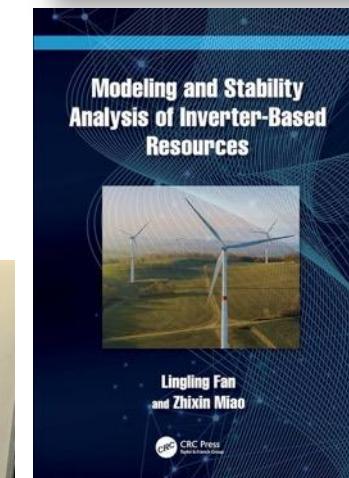
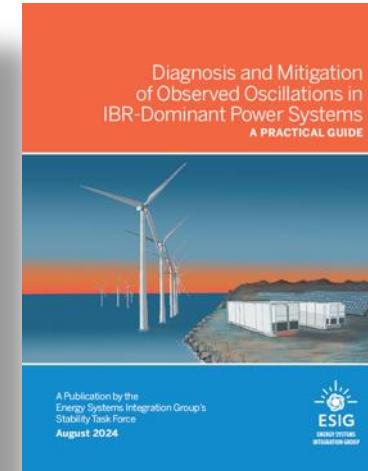
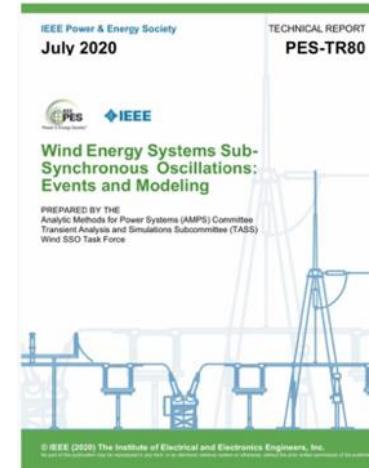
Highlights:

Lingling Fan, Professor, IEEE Fellow

Six years with MISO transmission planning; EIC of IEEE Electrification Magazine, AE of IEEE trans. Energy Conversion, chair of IEEE PES IBR SSO taskforce

Zhixin Miao, Professor

Six years as relay engineer; eight years with MISO transmission planning; expert of RT-Lab, HIL, large-scale power grid dynamics, hardware protection/control prototyping. AE of IEEE trans. Sustainable Energy; Chair, IEEE PES BPS-IBR Operation Challenges

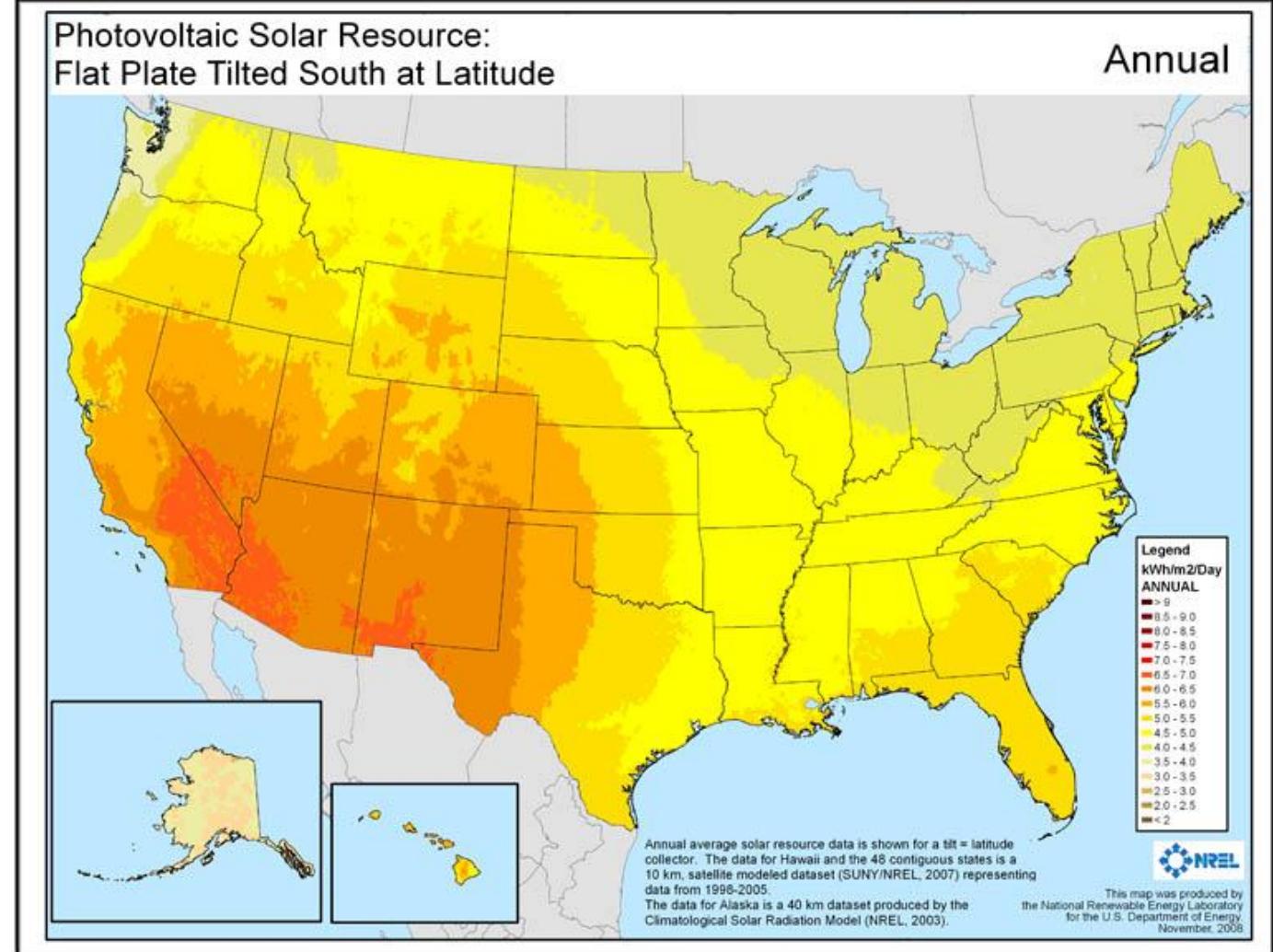


What is happening in the grid industry?

Solar, wind, HVDC



What is
happening in
the power
grid industry...



30 GW offshore wind by 2030

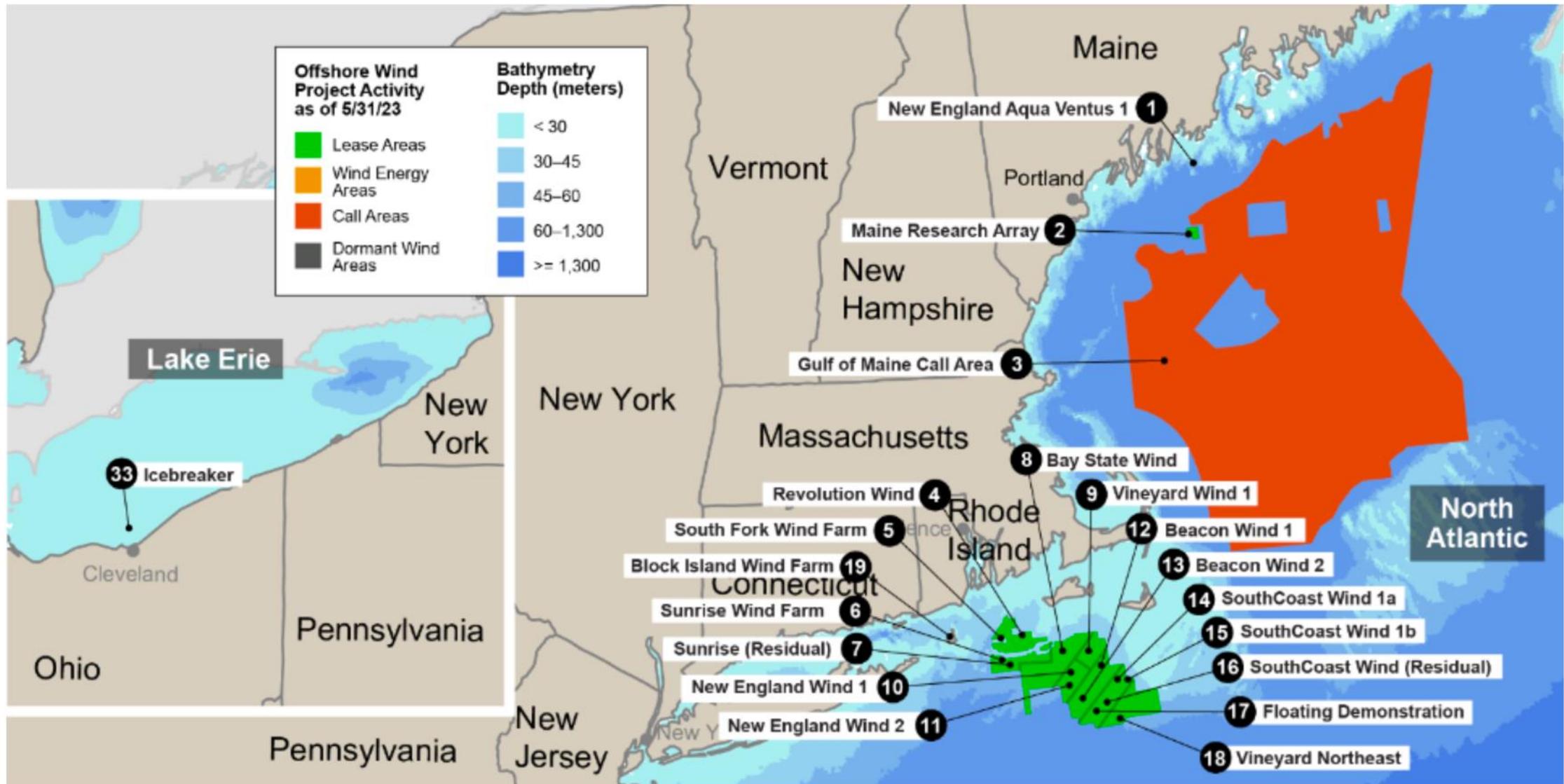
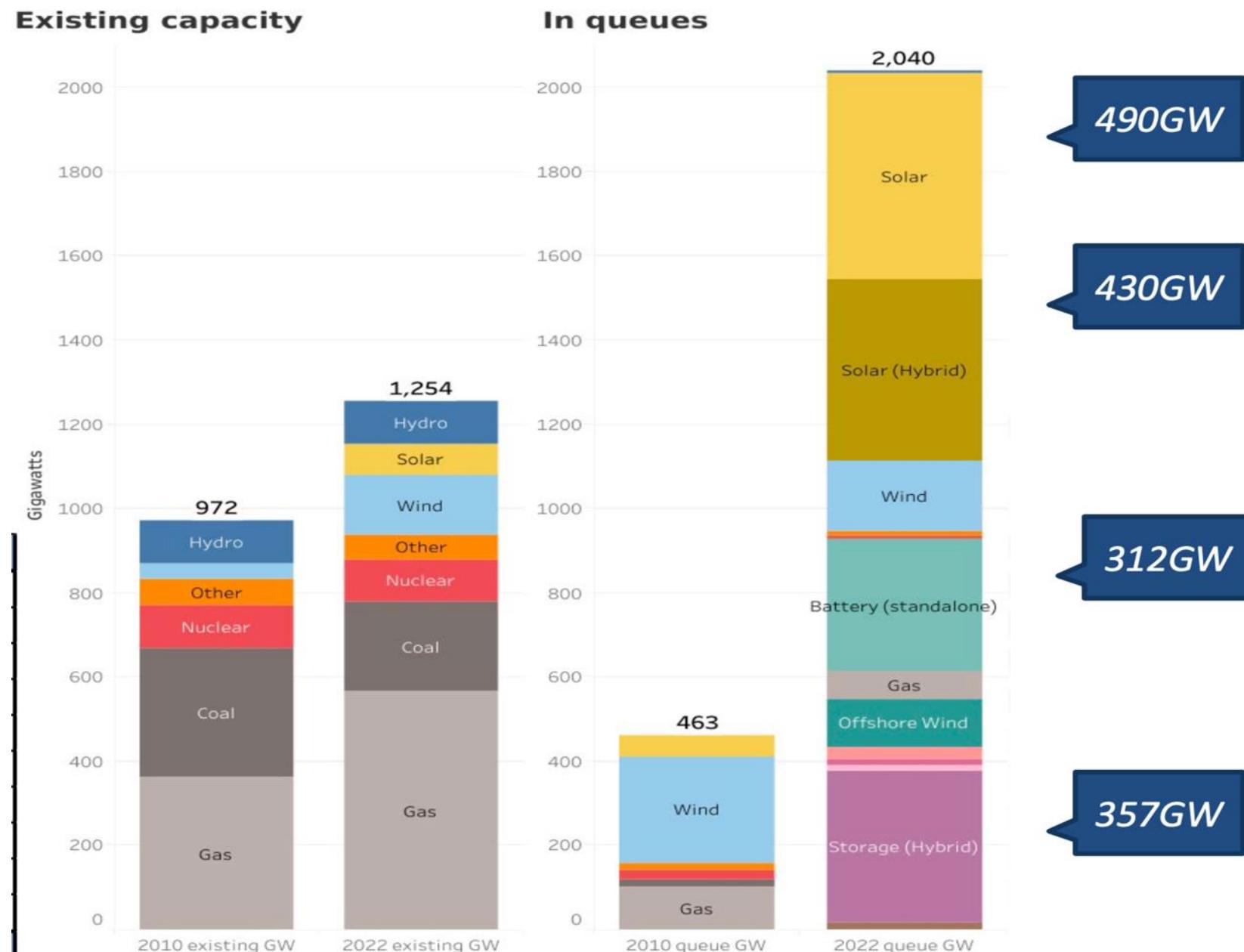


Image by John Frenzl, NREL

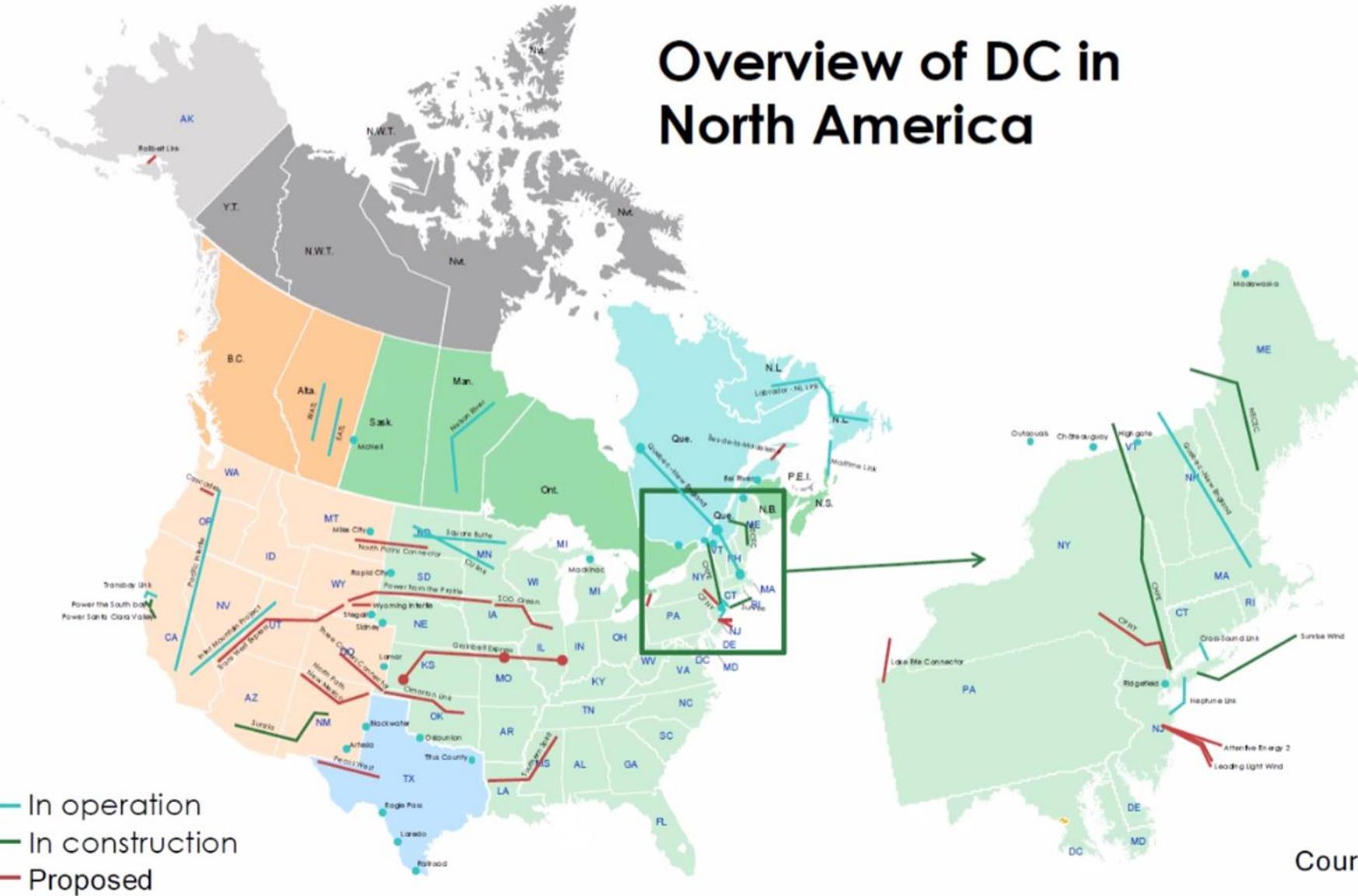
Inverter-based resource (IBR): interconnection queues:

920 GW solar in queue in 2022, a huge increase from the size of 2010 queue





Overview of DC in North America



Courtesy – DNV and EPRI

DOE Funding to address challenges and urgent needs

HVDC, IBR-related stability
(dynamics, protection)



Energy Department's American-Made High-Voltage Direct Current Prize Announces Four Winners

The U.S. Department of Energy's (DOE's) Office of Electricity today announced the four winners of the American-Made High-Voltage Direct Current (HVDC) Prize.

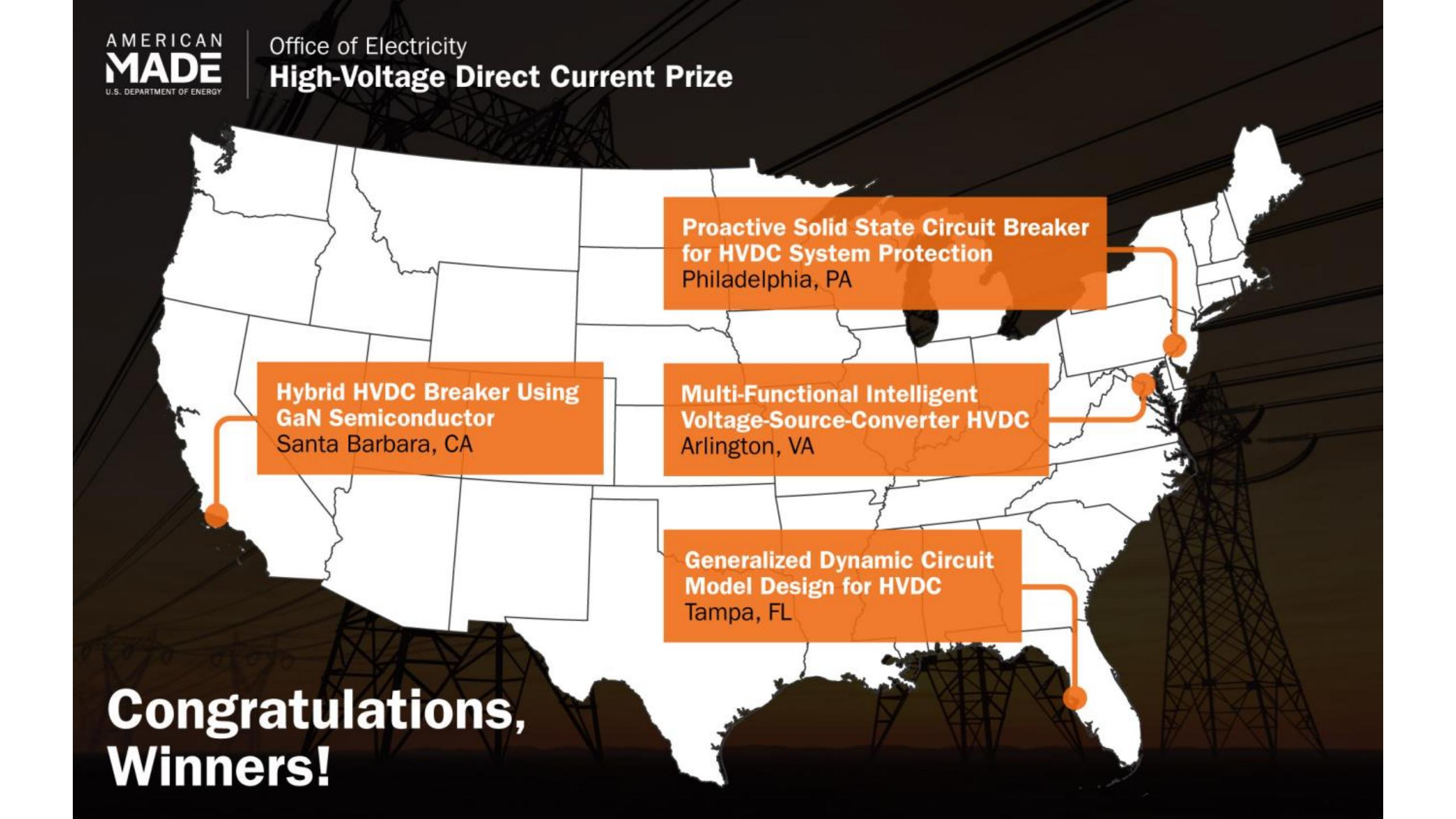
[Office of Electricity](#)

September, 7 2023

3 min

WASHINGTON, D.C. — The Department of Energy's (DOE's) Office of Electricity (OE) announced the four winners of the American-Made [High-Voltage Direct Current \(HVDC\) Prize](#). This \$200,000 prize—\$50,000 awarded to each winning team—incentivized competitors to share new technology solutions that improve the performance and resilience of the U.S. energy grid. The knowledge gained from this prize will help reduce technology gaps that hinder HVDC deployment in the United States and enable new innovative solutions to technical challenges in HVDC through the development of new hardware, controls, and advanced concepts.

"Ensuring that low-cost, clean energy is available to support and improve the lives of all Americans is a priority for the Office of Electricity," said Gene Rodrigues, Assistant Secretary for Electricity. "The ideas presented through the HVDC Prize will continue to strengthen the nation's grid and pave the way for new, cutting-edge solutions within the renewables industry."



**Hybrid HVDC Breaker Using
GaN Semiconductor**
Santa Barbara, CA

**Proactive Solid State Circuit Breaker
for HVDC System Protection**
Philadelphia, PA

**Multi-Functional Intelligent
Voltage-Source-Converter HVDC**
Arlington, VA

**Generalized Dynamic Circuit
Model Design for HVDC**
Tampa, FL

**Congratulations,
Winners!**

**1,200 MW Fault Induced
Solar Photovoltaic
Resource Interruption
Disturbance Report**

Southern California 8/16/2016 Event

June 2017

Frequency
measurement error404-446-2560 | www.nerc.com**900 MW Fault Induced
Solar Photovoltaic
Resource Interruption
Disturbance Report**Southern California Event: October 9, 2017
Joint NERC and WECC Staff Report

February 2018

Subcycle
overvoltage404-446-2560 | www.nerc.com**April and May 2018 Fault
Induced Solar Photovoltaic
Resource Interruption
Disturbances Report**Southern California Events: April 20, 2018 and
May 11, 2018
Joint NERC and WECC Staff Report

January 2019

Subcycle
overvoltage404-446-2560 | www.nerc.com**San Fernando
Disturbance**Southern California Event: July 7, 2020
Joint NERC and WECC Staff Report

November 2020

overcurrent

3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com**Odessa Disturbance**Texas Events: May 9, 2021 and June 26, 2021
Joint NERC and Texas RE Staff Report

September 2021

PLL loss of sync

3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com**Multiple Solar PV
Disturbances in
CAISO**Disturbances between June and August 2021
Joint NERC and WECC Staff Report

April 2022

**Panhandle Wind
Disturbance**Texas Event: March 22, 2022
Joint NERC and Texas RE Staff Report

August 2022

RELIABILITY | RESILIENCE | SECURITY
Momentary cessation
Slow active power
recovery**2022 Odessa
Disturbance**Texas Event: June 4, 2022
Joint NERC and Texas RE Staff Report

December 2022

RELIABILITY | RESILIENCE | SECURITY
Plant control interactions**2023 Southwest
Utah Disturbance**Southwestern Utah: April 10, 2023
Joint NERC and WECC Staff Report

August 2023

RELIABILITY | RESILIENCE | SECURITY
AC overcurrent, AC
overvoltage
PLL loss of sync**2022 California Battery
Energy Storage System
Disturbances**California Events: March 9 and April 6, 2022
Joint NERC and WECC Staff Report

September 2023

RELIABILITY | RESILIENCE | SECURITY
AC overcurrent, AC
overvoltage
Unbalanced AC current3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

Advanced Systems Integration for Solar Technologies (ASSIST): Situational Awareness and Resilient Solutions for Critical Infrastructure

The Advanced Systems Integration for Solar Technologies (ASSIST): Situational Awareness and Resilient Solutions for Critical Infrastructure funding program will improve situational awareness of solar energy systems, especially at critical infrastructure sites, increase resilience to cyber and physical threats, and strengthen solar integration on the grid. The U.S. Department of Energy (DOE) announced [the program](#) on October 15, 2018, and on March 25, 2019, it [announced 10 project selections](#).

"I have no higher priority than to support the security of the country's critical energy infrastructure," said U.S. Secretary of Energy Rick Perry. "These projects will work to give solar technologies greater resiliency as they are integrated into our electric grid. A reliable electricity grid is essential to our national and economic security, and the everyday lives of American people."

The projects will develop new technologies, including: "grid-forming" inverters, cyber-secure communications for critical grid components during emergency operations, smart sensors, and automated control schemes. The research will culminate in grid management tools and models that show how solar situational awareness will enhance power system resilience at critical infrastructure locations such as hospitals or emergency response centers.

The following research projects were selected:

- Arizona State University (Tempe, Arizona): \$3.6 million
- Kansas State University (Manhattan, Kansas): \$2.9 million
- North Carolina State University (Raleigh, North Carolina): \$3 million
- Siemens Corporation, Corporate Technology (Princeton, New Jersey): \$5 million
- University of North Carolina at Charlotte (Charlotte, North Carolina): \$3.7 million
- University of Oklahoma (Norman, Oklahoma): \$4.5 million
- University of South Florida (Tampa, Florida): \$1 million**

The following research projects will also conduct field validation of the advanced technologies that they develop:

- Electric Power Research Institute, Inc. (Knoxville, Tennessee) with multiple partners, including Pecan Street and Austin Energy: \$5 million
- Electrical Distribution Design, Inc. (Blacksburg, Virginia), partnering with Pepco: \$3 million
- University of Utah (Salt Lake City, Utah), partnering with PacificCorp: \$4 million

These technologies will enable grid operators to integrate increasing amounts of solar generation onto the grid in a cost-effective, secure, resilient, and reliable manner.

DOE EERE SETO FOAs: April 2023: OPTIMA



SOLAR Funding Program

U.S. DEPARTMENT OF
ENERGY | Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY
SOLAR ENERGY TECHNOLOGIES OFFICE

Operation and
Planning Tools for
IBR Management and
Assurance in Future
Power (OPTIMA)

12 projects, 47
millions

National Labs: (4)
PNNL, NREL (2),
Oak Ridge (1)

Industry: (2)
Quanta Technology
MISO

Universities (6)
USF
Washington State
Arizona State
Iowa State
GaTech
FIU

Topic Area 3: Rapid System Health and Risk Assessment Tools for Grid Operators

University of South Florida

Project Name: SPRING: Stability Predication for IBR-Penetrated Grids Enabled by Digital Twins

Location: Tampa, FL

DOE Award Amount: \$2.9 million

Awardee Cost Share: \$930,000

Principal Investigator: Lingling Fan

Project Description: Inverter-based resources (IBRs) have more complex, dynamic behaviors than traditional power generation sources. Current tools only allow grid operators to see IBR behaviors after a grid event such as a storm or cyberattack has occurred. This project is developing and demonstrating tools for utilities and power plant operators to monitor the dynamic behaviors of IBRs in real time and predict future behaviors. The tool will integrate detailed, real-time measurement data, advanced analytics, and visualization techniques. It will also use digital twin technology, which creates a virtual model of a real-world system. The tool will provide automatic event analysis, reporting, and recommendations for reliability risk mitigation and will be demonstrated in realistic test systems and a utility solar power plant substation.

Overview of the SPRING project

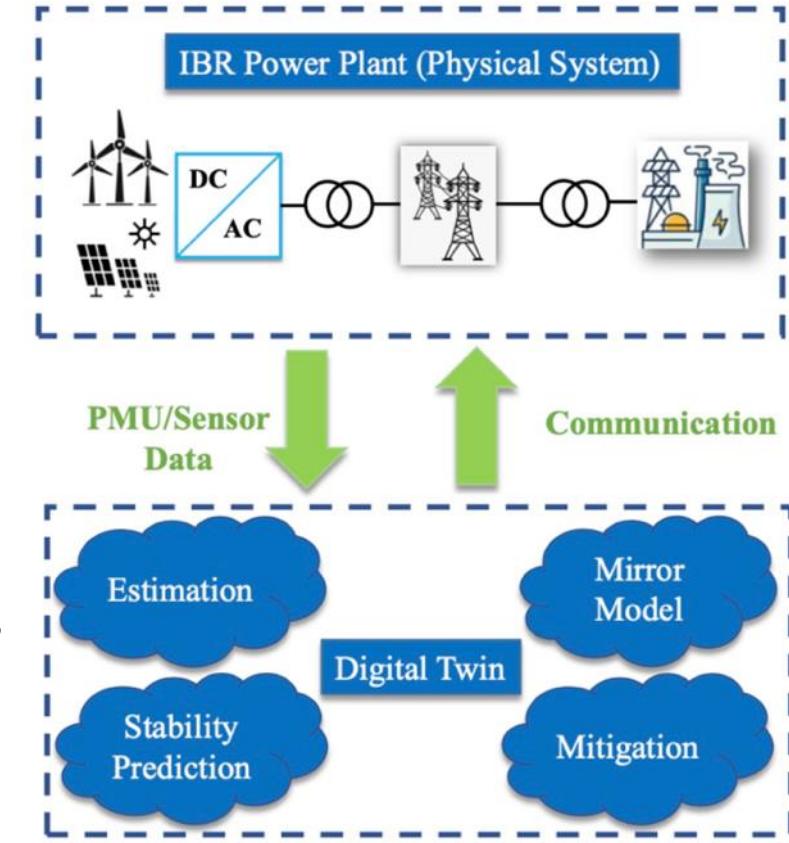


Integrate the **three core technologies** into building digital twins for solar PV power plants:

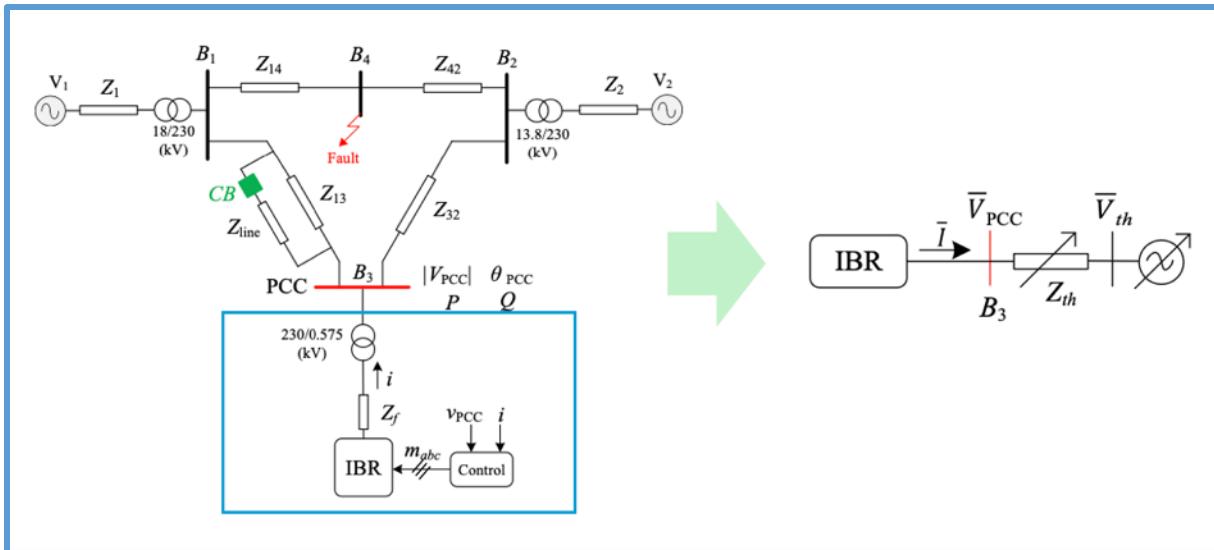
- **High-fidelity dynamic modeling for computer simulation**
- **Real-time data streaming**
- **Data-driven modeling, estimation, analytics**

Outcomes:

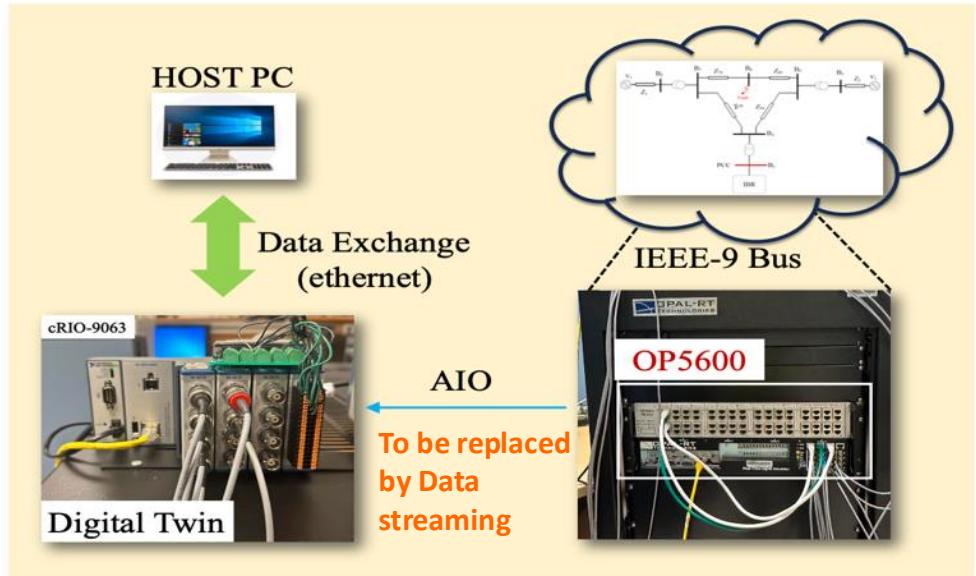
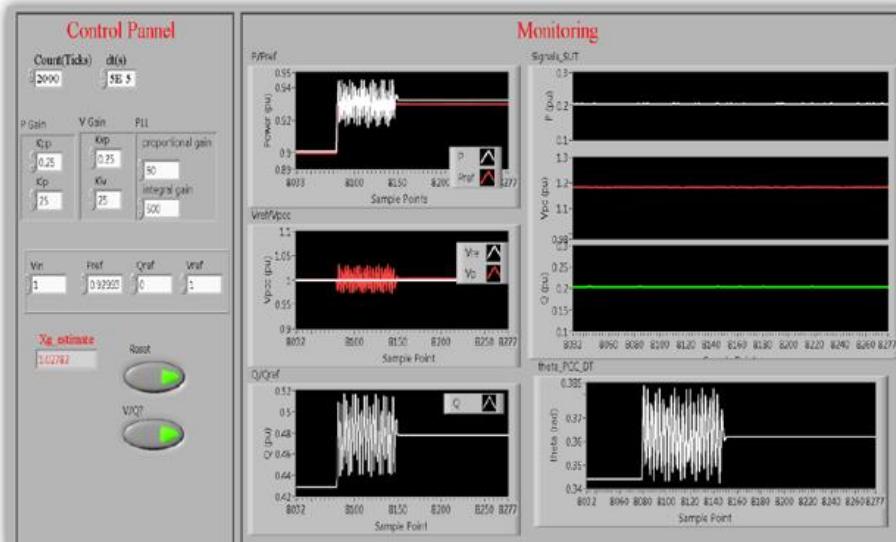
- **Rapid PV plant dynamics monitoring and grid condition estimation**
- **Real-time stability prediction and mitigation**



Proof of Concept: Predict a solar PV plant's dynamic performance at real time



Lab demo ready:



Measurement data:

P , Q , V collected by PMUs at the POI of an IBR power plant

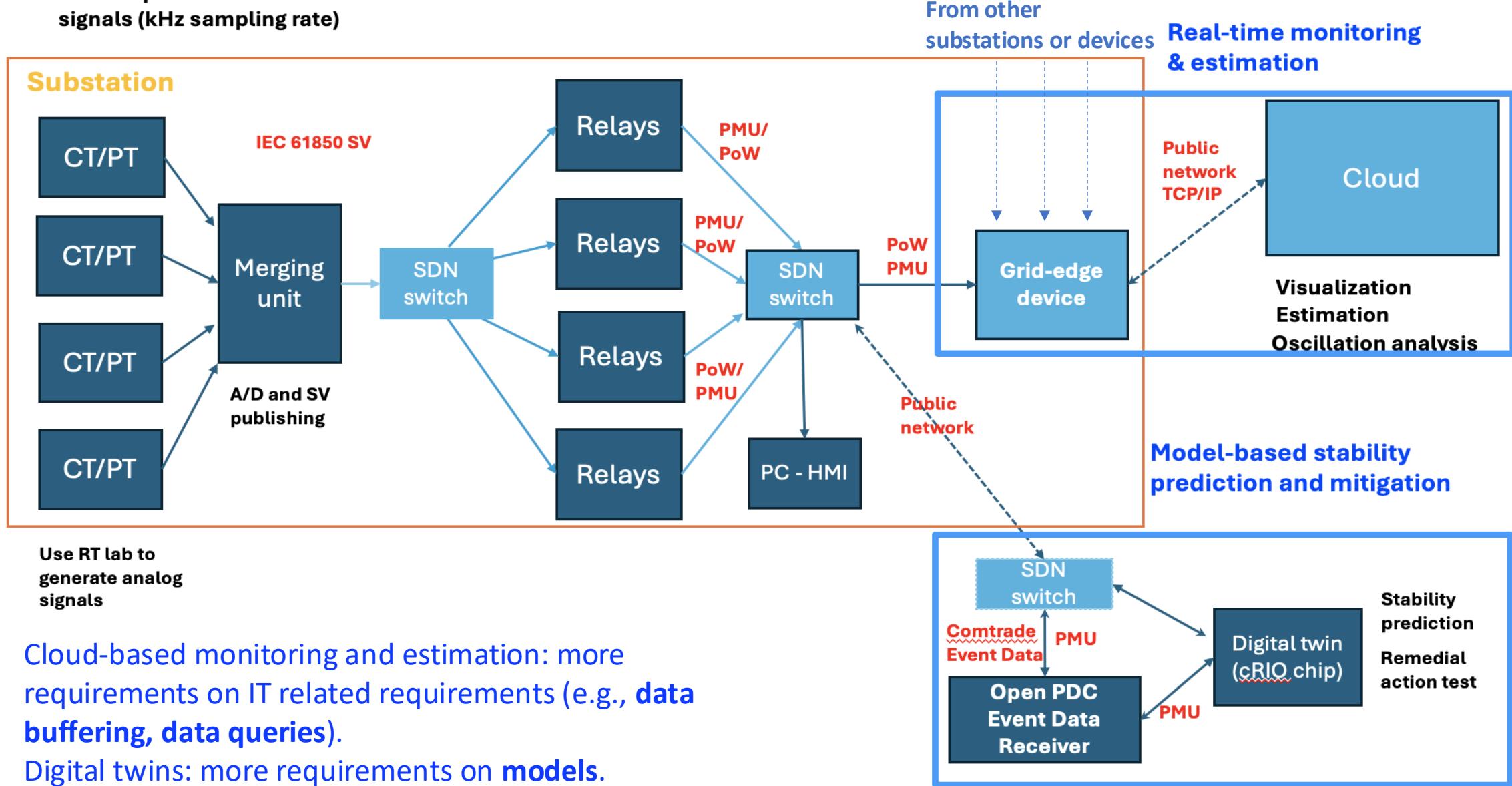
Real-time simulation model with I/O:

The grid is represented by an equivalent and the parameters of the equivalent are estimated based on P , Q , V .
Event replication of stability prediction (conduct contingency analysis ahead of time)

Preliminary work: R. Mittal, Z. Miao, L. Fan, "A Digital Twin for IBR Power Plants," under review, IEEE trans. Energy Conversion

The proposed data flow architecture

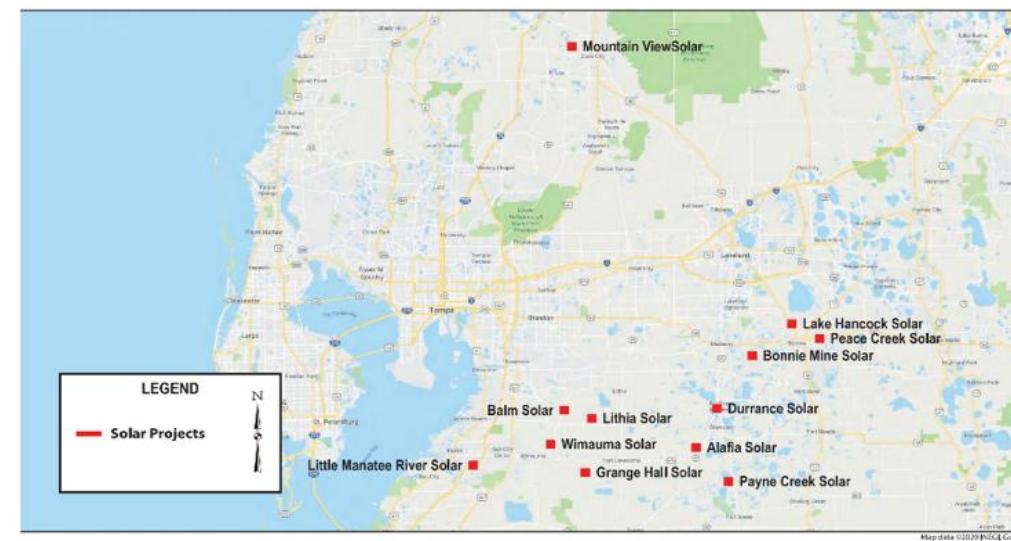
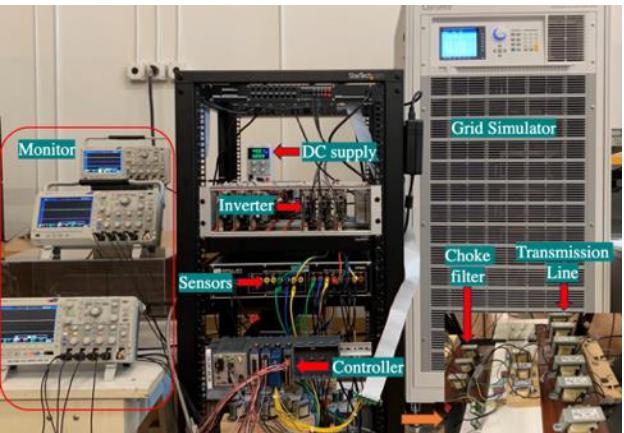
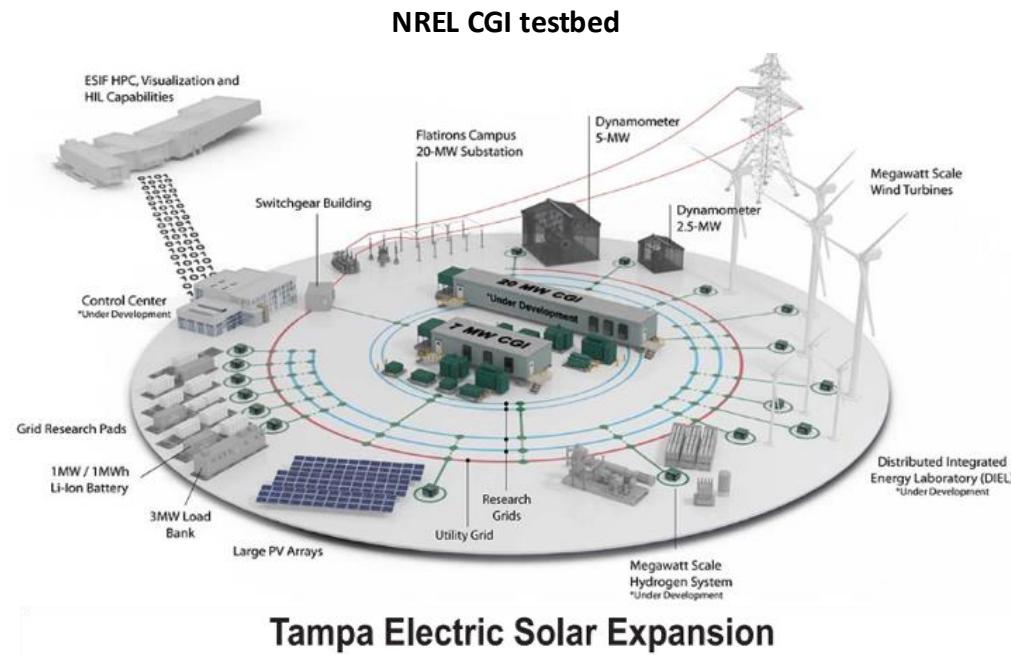
SV: sampled value of waveform signals (kHz sampling rate)



1. Cloud-based monitoring and estimation: more requirements on IT related requirements (e.g., **data buffering, data queries**).
 2. Digital twins: more requirements on **models**.

Field demonstration

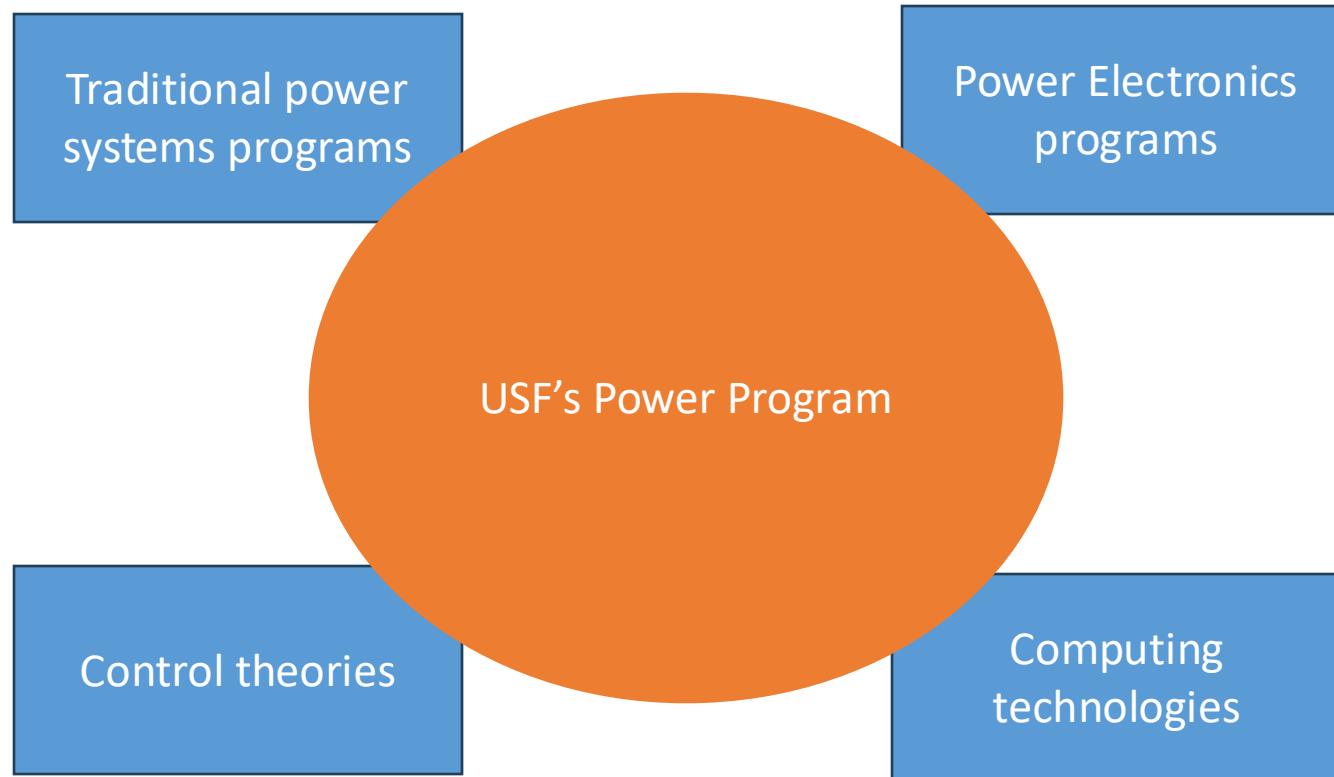
- Three stages:
 - Lab environment hardware-in-the-loop (HIL) tests
 - NREL 20-MW CGI testbed demonstration
 - Tampa Electric substation field demonstration



Past experience with the 1-MW BESS and 430-kW solar PVs, e.g., 0.1 Hz-1000 Hz admittance measurements available for the BESS.

USF's Power Program highlights

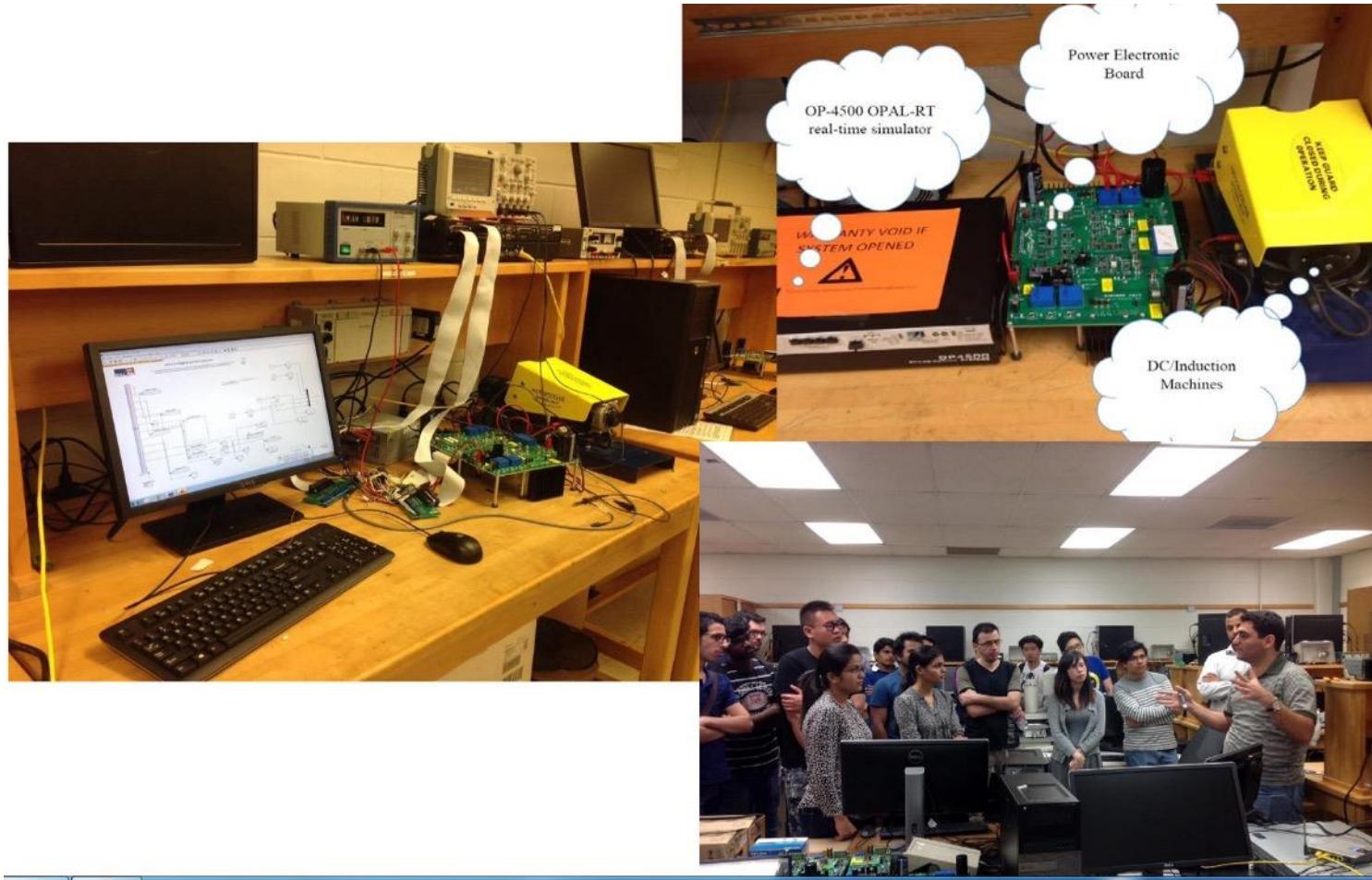




Fill the gap (an integrated power systems and power electronics program) to address the grid industry's needs for workforce in **Inverter-based resources integration, HVDC**.

One of the few schools in US provides students **a comprehensive set of skills** of power grid operation, including the highly demanded sets: **EMT simulation, converter control & protection.**

RT-LAB Enabled Power system/machine drives Lab



Integrating the **state-of-the-art real-time simulation** technology into teaching and deliver hands-on experiences.

Students learn electromagnetic transient simulation skills.

Students connect theories to observations.

USF is a part of the Consortium of Universities for Sustainable Power (CUSP) led by Prof. Ned Mohan (1946- 2024) of University of Minnesota

The power lab course kicked off in 2017.

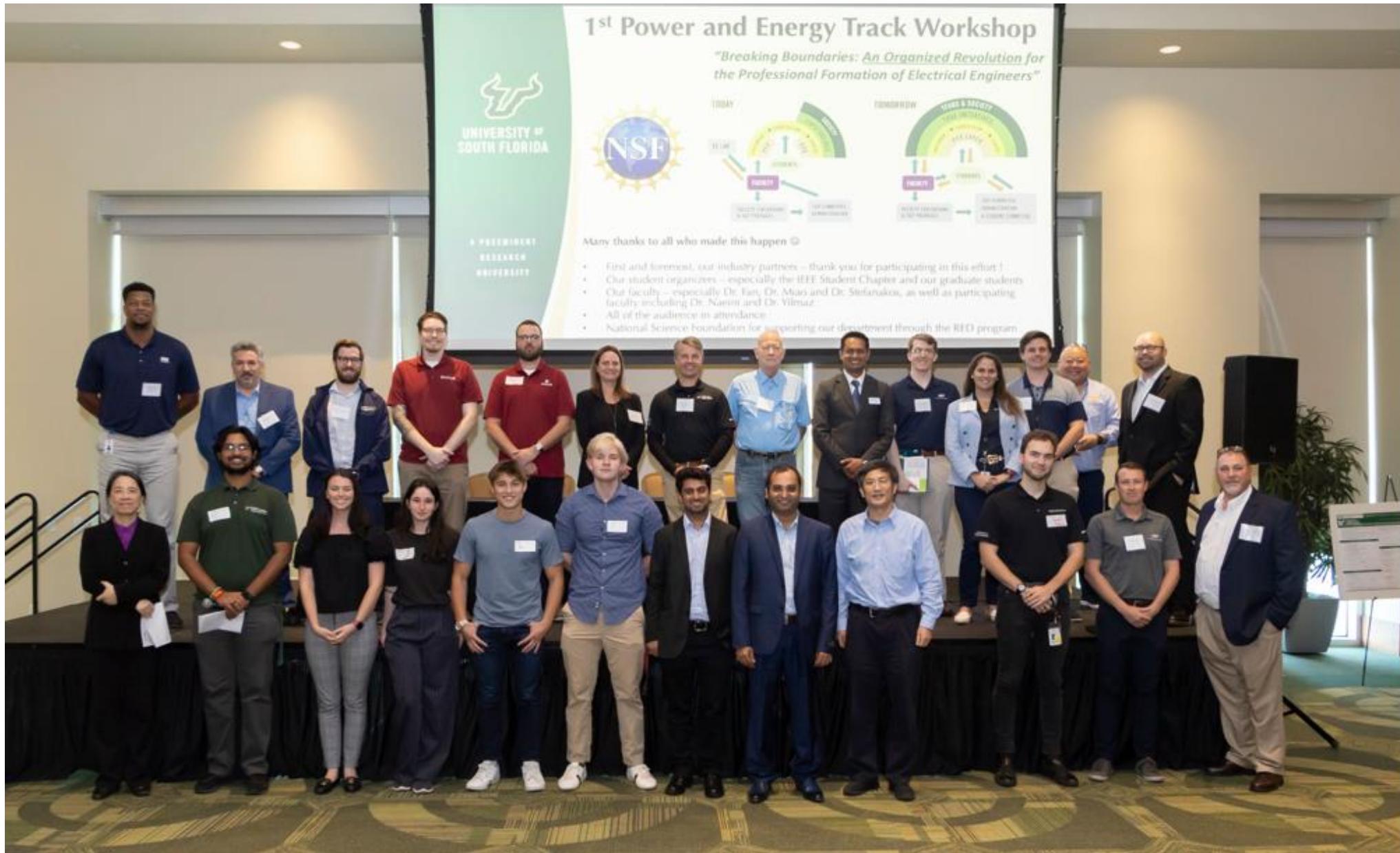
We expand the **motor drive lab** setup designed by the UMN group to **power systems/protection** lab design.
We bring the powerful **real-time digital simulators** into providing hands-on experience.

The protection lab

Acknowledge **SEL's strong support** to our program.



Transmission line relays
High precision PQ meters
Phasor-measurement units
Point-on-wave measurement units



March 21, 2023. 136 attendees (20 from the local industry, 116 USF students)



Workforce training outcomes

Javad Khazaei, Assistant Professor at Lehigh University, graduated from the USF power program in 2016.

The screenshot shows the Lehigh University website's faculty profile page for Javad Khazaei. At the top, the Lehigh University logo and the P.C. ROSSIN COLLEGE OF ENGINEERING AND APPLIED SCIENCE are visible. The navigation bar includes links for Home, About, Academics, Research, Faculty, News, Podcast, Contact, Search, and Inquire. The main content area features a video player showing Javad Khazaei speaking. Below the video is a "Watch on YouTube" button. To the right is a portrait photo of Javad Khazaei, a smiling man with dark hair and a beard, wearing a grey suit, white shirt, and patterned tie. His contact information is listed: Assistant Professor, Electrical & Computer Engineering, khazaei@lehigh.edu, 610-758-2602, Office: Packard Lab, Room 214, 19 Memorial Drive West, Bethlehem, PA 18015, Laboratory: Packard Lab 216, 19 Memorial Drive West, Bethlehem, PA 18015, and a Scholarship section. A Google Scholar link and an ACCEPT AND CONTINUE button are also present. A cookie consent banner at the bottom states: "We use cookies and similar technologies to understand how you use our site, to personalize content and to improve functionality. By continuing to use this site, we will assume you agree with our use of these technologies as described in the Privacy Statement."

LEHIGH UNIVERSITY | P.C. ROSSIN COLLEGE OF ENGINEERING AND APPLIED SCIENCE

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Assistant Professor Javad Khazaei, Lehigh University

Watch later Share

Watch on YouTube

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Laboratory: Packard Lab 216, 19 Memorial Drive West, Bethlehem, PA 18015
Scholarship:

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Google Scholar [ACCEPT AND CONTINUE](#)
Personal Webpage



Li Bao • 1st

Senior Engineer at Eversource Energy

5mo •

...

The three-day training was an unforgettable experience. It was an honor to meet John Undrill and to connect with many experienced engineers in the field.



Faria Kamal • 2nd

Clean Energy Enthusiast | Senior Engineer, System Pla... [+ Follow](#)
5mo • Edited •

This week, I had a chance to take a step back and think about how much engineering goes behind the software we use everyday. I had the honor to meet John Undrill, the father and architect of ...more



Li Bao, graduated in July 2022

Senior Engineer at Eversource (the largest utility in the New England region), MA

Experience

Senior Engineer

Eversource Energy
Aug 2022 - Present • 2 yrs 5 mos
Westwood, Massachusetts, United States

- Participate the studies for South Fork Wind, Revolution Wind and Sunrise Wind.
- Conduct power system contingency, steady-state, load flow, dynamic, TRV, TOV, energisation & ...see more

Courtesy Research Associate

University of South Florida
Mar 2024 - Present • 10 mos
Tampa, Florida, United States • Remote

- 1. Collaborate with USF Smart Grid Power System Lab group as an industry advisor in developing research of practical values....
...see more

Secretary

IEEE PES task force: Design IBR Models
May 2023 - Present • 1 yr 8 mos

The goal of the task force is to design a set of BPS-connected IBR models for grid planning. Those models are efficient for computation. They can be input/output frequency-domain admittance models, or ...see more

University of South Florida

5 yrs 6 mos

• Graduate Research Assistant

- Jan 2017 - Jun 2022 • 5 yrs 6 mos
- Modeling and analysis of electrical vehicle charging system in RT-Lab.
 - Investigation of reactive power devices in weak-grid connected IBR system....
...see more

• Graduate Teaching Assistant

Jan 2017 - Jun 2022 • 5 yrs 6 mos

Assisted the professor in teaching following courses:
1. Power System Analysis...

Zhengyu Wang, graduated in December 2022

Senior Transmission Engineer at RWE



Zhengyu Wang

Zhengyu Wang · 1st
Senior Transmission Engineer at RWE
Austin, Texas, United States · [Contact info](#)

212 connections

Experience



RWE

Full-time · 2 yrs 8 mos

Austin, Texas, United States · On-site

- **Senior Transmission Engineer**

Jul 2023 - Present · 1 yr 6 mos

Transmission Analysis:

- Conduct transmission studies for project planning purposes, including site-specific analysis, a ...see more

❖ PowerWorld, TARA/TARA Studio and +3 skills

- **Transmission Engineer**

May 2022 - Jun 2023 · 1 yr 2 mos

Serve in the Western Transmission Team at RWE Global Transmission. Perform available transfer capacity analysis of selected points of interconnection and systems for Greenfield Study by using power f ...see more

❖ PowerWorld, TARA/TARA Studio and +3 skills



University of South Florida

4 yrs 10 mos

Tampa/St. Petersburg, Florida Area

- **Instructor**

Jan 2020 - May 2022 · 2 yrs 5 mos

On-site

Introduce electromechanical energy systems to undergraduate students as a graduate instructor at the University of South Florida, including AC circuits, synchronous machines, and induction machine ...see more

❖ SimPowerSystems, SimScape and +2 skills

- **Graduate Teaching Assistant**

Aug 2017 - Dec 2019 · 2 yrs 5 mos

Serve multiple undergraduate/graduate courses and labs as graduate teaching assistants including fundamental electromechanical energy systems, power electronics, energy delivery systems, cor ...see more



Ratik Mittal, Ph.D. • 1st

Engineer III @ Quanta Technology || PhD USF || EMT Simulations ...
3mo • 🌎

...

From research to reality!

After years of dedication, perseverance, and countless hours of ...more



Ratik Mittal, graduated in Summer 2024. Started working at **Quanta Technology** in August 2024.

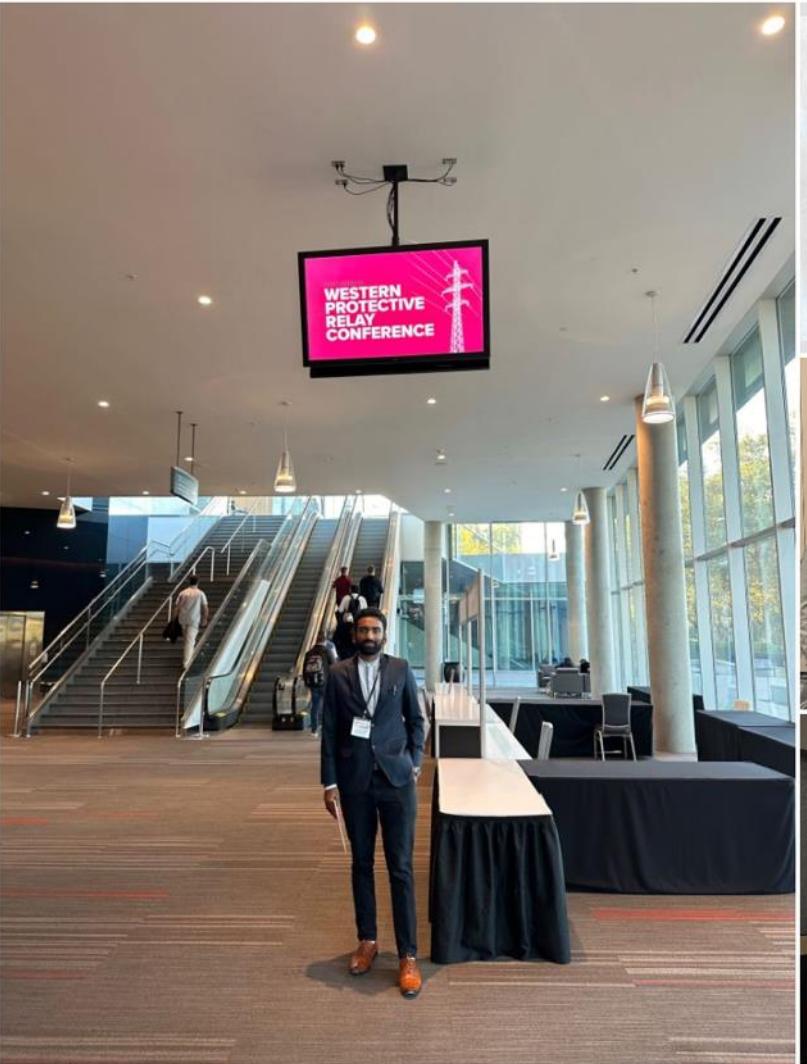
Aditya ram Raghuramulu • 1st

Master's in Electrical Engineering at University of South Florida Specializ...

1mo • Edited •

...

I recently attended the 51st Annual Western Protective Relay Conference 2024 in Spokane, Washington, from October 21-24, along with the 28th SEL Technical Seminar. It was an incredible opportunity to gain insights into various ...more



3

comments

Aditya ram Raghuramulu, one year into the MS program, got an intern position at **SEL**.



Aditya is seen with the SEL founder Ed Schweitzer.

Nancy Praveen Nattala, an MS graduate, got a full-time job at **Castillo Engineering**.

Posts by Nancy



Nancy Praveen Nattala • 1st

ELECTRICAL ENGINEER 1 | AUTOCAD | MATLAB SIMSCAPE & SIMULINK ...
5mo • Edited •

Exciting news! 🌟 I am honored to join **Castillo Engineering**, one of the fastest-growing solar firms in the country. With a Master's degree in Electrical Engineering from the **University of South Florida**, I look forward to ...more



42

18 comments



Nancy Praveen Nattala • 1st

ELECTRICAL ENGINEER 1 | AUTOCAD | MATLAB SIMSCAPE & SIMULINK ...
5mo • Edited •

I am beyond excited to share that I have graduated from the **University of South Florida** with a Masters degree in Electrical Engineering! 🌟 ...more





William Wingate

Electrical Engineer at TECO Energy-
Electrical System Reliability

Experience



Tampa Electric

Full-time · 2 yrs 8 mos

- **Electrical Engineer**

Jul 2023 - Present · 1 yr 6 mos
United States

Electrical System Reliability

- **Electrical Engineer**

May 2022 - Jul 2023 · 1 yr 3 mos
Tampa, Florida, United States

Solar Operations



Electrical Engineer Co-op

TECO Energy · Part-time

Jun 2021 - May 2022 · 1 yr
Tampa, Florida, United States

- Solar Power Plant DC Arc Flash analysis and coordination using ETAP Software.
- Assist in Engineering support for Solar Plant Operations across all TECO Solar Power Plants... [...see more](#)



Industrial Electrical Field Technician

TAW®

Feb 2018 - Apr 2021 · 3 yrs 3 mos
Lakeland, Florida Area

* Responsible for Electrical performance and compliance testing for utility and industrial distribution and feeder protection and control systems.... [...see more](#)

Education



University of South Florida

Bachelor of Engineering - BE, Electrical and Electronics Engineering

2018 - May 2022

Grade: 3.6

Activities and societies: * International Society of Automation (USF Student Chapter) Member since November 2020... [...see more](#)

Degree Track areas of focus:

- * Power, Energy, and Sustainability...

[...see more](#)



Osmide Alvarez Almaguer · 1st

Electrical Engineering Senior at USF. Coop @ TECO Energy

Bradenton, Florida, United States · [Contact info](#)

[60 connections](#)



Zhixin Miao, Ratik Mittal, Ph.D., and 7 other mutual connections



TECO Energy

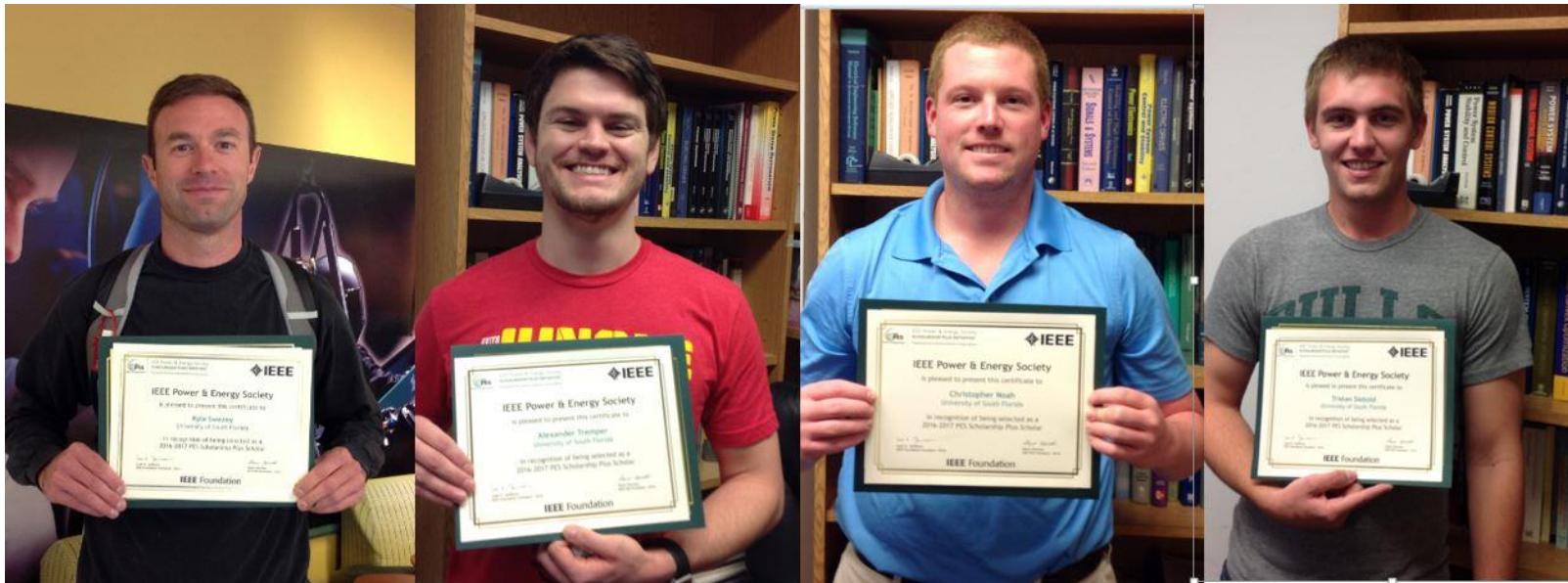


University of South Florida

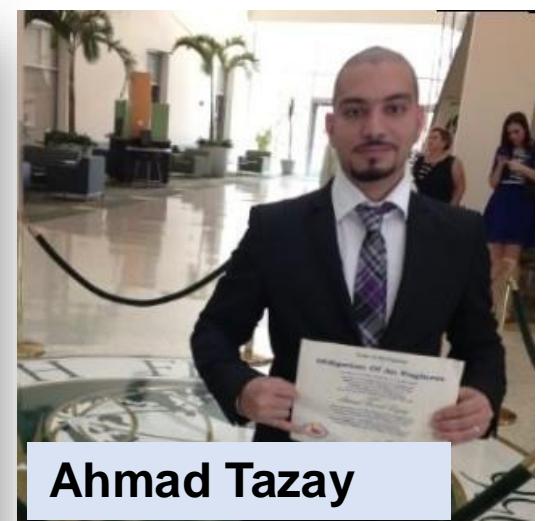
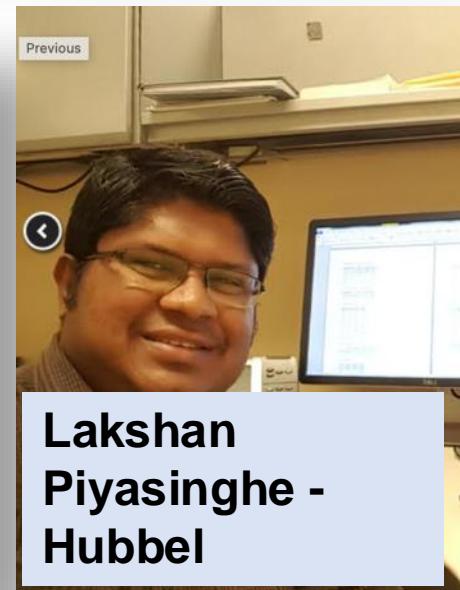
 [Message](#)

[More](#)

IEEE PES scholarship for undergraduates



SPS lab: 25 Ph.D. graduates since 2011





Fall 2016 Group Photo

Fall 2017 NAPS meeting





2018 NAPS meeting at North Dakota State University

From Right to Left

- **Yin Li:** GE Energy Consulting
- **Abdullah Alassaf**
- **Sulaiman Almutairi**
- **Ibrahim Alsaleh**
- **Mohammed AlQahtani**
- **Tony Wang:** RWE Texas, Senior Engineer
- **Anas Almunif**
- **Li Bao:** Eversource, Boston Senior Engineer
- **Miao Zhang:** Sifang

IEEE PESGM 2022 at Denver Colorado



Hakim Alsaif's paper selected as a best paper.



Photographer: Dr. Yi Yang (US DOE SETO)

IEEE PESGM 2024 at Seattle, Washington

