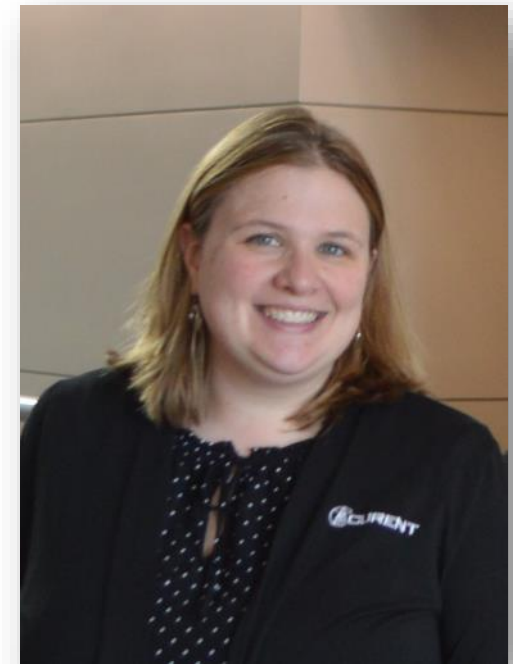




Overview of University and Precollege Education and Outreach Programs



Chien-fei Chen & Anne Skutnik
NSF/DOE 9th Annual Review
November 6, 2020
Virtual



UNIVERSITY PROGRAM

Workforce Development Roadmap: Highlights

Year 1~ 3	Year 4 ~ 6	Year 9 Results	Year 7 ~10
Generation I	Generation II	Generation III	Generation III
45 total REUs Grad & UG ratio ~ 3.0	100 total REUs Grad & UG ratio ~ 2.0	133 total REUs Grad & UG ratio at 2.6	140 total REUs Grad & UG ratio < 2.0
Create Young Scholars summer program	Reach 80 YSP participants	Reached 107 YSP participants by Year 9	Reach 120 YSP
Create additional summer programs for girls and students from diverse populations	Continue to recruit middle school girls and students to Smart Grid camp and Adventures in STEM	RPI Solar Build workshop in Nigeria Collaborated with NIMBioS for middle school girl workshop	Pre-College programs institutionalized at respective schools (e.g. RPI Solar Camp, CURENT RET at UTK)
Create and disseminate curriculum related to CURENT	Work with RET teachers to create/share curriculum (website)	Shared ebook and lesson content online Pre-college outreach reached one of the highest	Continue to work with educators to disseminate ebook, solar modules, and other curriculum content

University Education Program Highlights

- **13 summer REUs**; four TU students worked on cross campus-teams; 10 undergraduate students continued summer research
- **46** academic-year undergraduate researchers
- **8** internships (undergraduate and graduate)
- **33** journal articles co-authored with students (core funding)
- Publications demonstrating interdisciplinary and cross-campus collaboration
- **Student awards:** UTK Citation Award in Extraordinary Professional Promise (2), EECS Min Kao Fellowship (2), UTK Chancellor's Citation for Extraordinary Professional Promise (1), UTK Chancellor Graduate Student Fellowship (1), Tennessee Fellowship for Graduate Excellence (1), the UT TOP100 Fellowship (1) and UTK Outstanding EE GTA Award. One Ph.D. student received 3rd Prize Paper award from CSEE Journal of Power and Energy Systems.
- **1 Textbook:** *Power System: Modeling, Computation and Control* published by Dr. Joe Chow

Virtual Research Experience for Undergraduates (REU)

Research

- One-on-one mentorship
- Research paper and poster presentation
- Graduate school information

Technical training

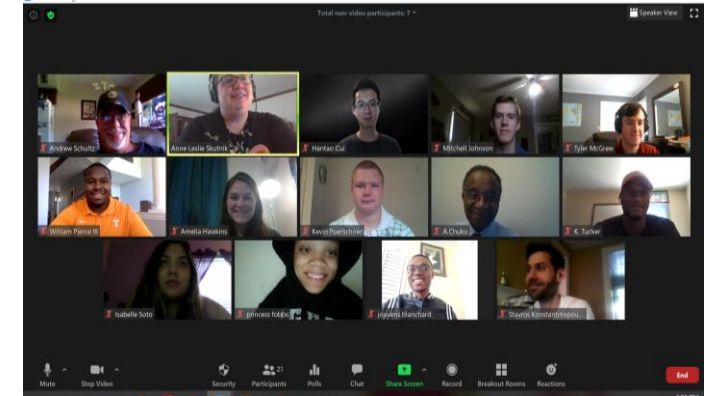
- Power engineering seminar series
- Workshops (e.g. Python,, literature reviews)
- Training from mentors on technical programs and software

Professional skills and culture of inclusion

- Technical writing and resumes/LinkedIn workshop
- Data visualization workshop
- Inclusion seminars

Industry connectivity

- Presentations from ORNL, EPRI
- Graduate school readiness talks



Some of CURENT REUs, Mentors, and Staff on Zoom July, 2020

Additional Highlights:

13 REU students in Year 9

- 4 TU students participated in cross-campus collaboration
- **50% REUs** were women and underrepresented minorities

Examples of Major REU Projects

- **Cyber security:** Identifying Vulnerabilities within a PMU by Alexis Ayers (Pennsylvania State), Jin Young Lee (UTK), & Dr. Sun (UTK).
 - **Power system:** Analyzing the Dynamics of a Power System with Active and Reactive Power Controllers to Maximize Power System Stability by Amelia Hawkins (Tennessee Technological), by Dr. Hector Pulgar (UTK)
 - **Power system:** Simulation and Prediction of Power System States by Quanizia Hoskins (Tuskegee), Dr. Ndoye (Tuskegee) & Dr, Abur (NEU)
 - **Power system:** Time Domain Simulation with ANDES by Princess Fobbs, Jouvens Blanchard (Tuskegee), Kalan Tucker (Tuskegee), Daniel Douglas (RIP), Stravos Konstantinopoulos (RPI), Dr. Ospiov (RPI), Dr. Chow (RPI), Dr. Karam (Tuskegee), Dr. Murphy (Tuskegee), Dr.Oni (Tuskegee), Dr. Cui (UTK) & Dr. Tomsovic (UTK).
-
- **Power electronics:** Switching Performance and Thermal Management of a GaN HEMT in a DBC Module for a Boost Converter Application by Jacob Buresh (Wichita State) & Mitchell Johnson (U of Connecticut), Dr. Bai (UTK).
 - **Power electronics:** Optimization & Database System for Power Electronics Converter Design Automation by Tyler McGrew (Miami U.), Jared Baxter (UTK), & Dr. Costinett (UTK).
 - **Interdisciplinary:** The Impacts of COVID-19 and Hurricane on Vulnerable Population Thru Tweeter Data Mining & Social-psychology by William Andrew Schultz (Saint Ambrose), Zhenning Young (UTK) & Rus Refati (UTK), Dr. Chen (UTK).

Undergraduate Ambassadors Program

Technical Skills

- Power and energy degree concentration
- Center-focused research
- One-on-one mentorship
- Senior design project

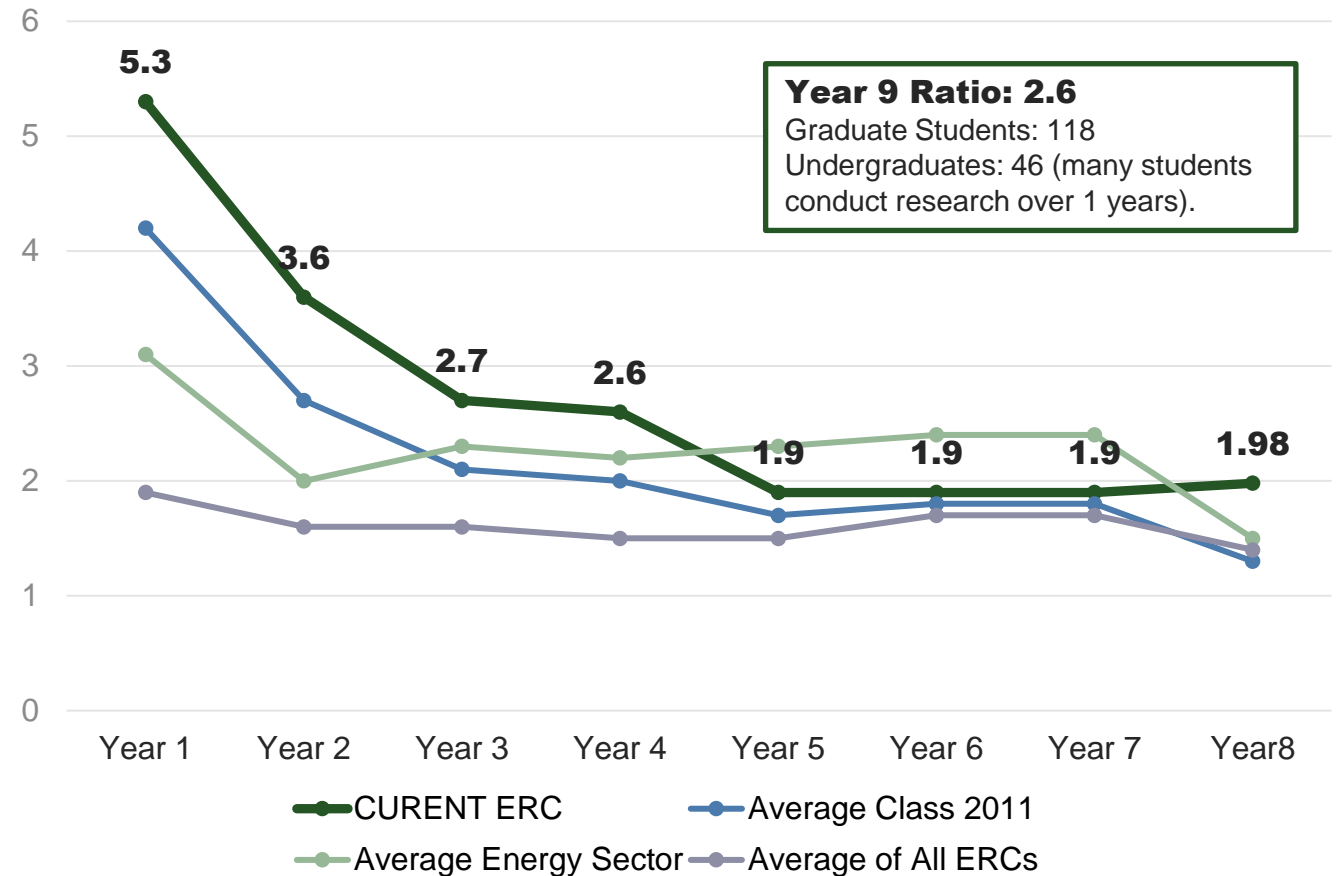
Workforce Preparation

- Professional and leadership training
- Internships, conferences
- Inclusion training
- Networking and industry seminars

Community Engagement

- International experiences
- K-12 outreach
- Student organizations
- Professional societies

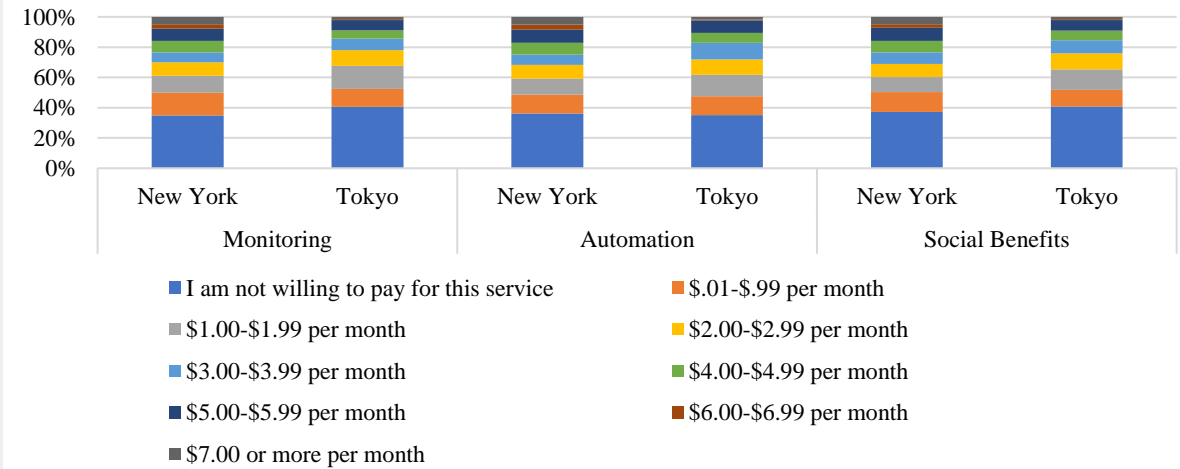
Progression of Grad/UG Ratio



Example of Undergraduate Publications

Chen, C.-F., Xu, X., Adams, J., Brannon, J., Li, F., & Walzem, A., (2020).

When East meets West: understanding residents' home energy management system adoption and willingness to pay in Japan and in the United States. *Energy Research and Social Science*, 69, 101616.

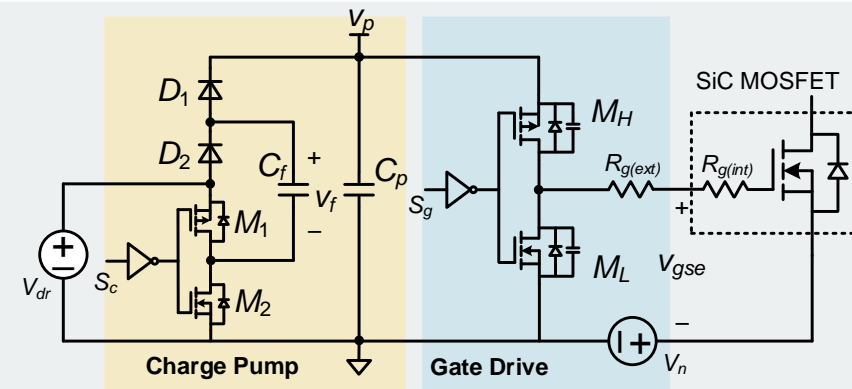


Distribution of willingness to pay for certain HEMS features

Handong Gui, Jordan Jones, and Leon Tolbert

“Charge pump gate drive to improve switching speed of SiC MOSFET”

2020 IEEE Applied Power Electronics Conference



Proposed gate drive circuit

Example 1: Cross-campus Collaboration (RPI-TU-UTK)

- **Project:** Transient Security and Small-Signal Stability Assessment using 2D Convolutional Neural Networks (REU project)
- **Goals:** Develop methods to assess power system N-1 security and small signal stability
- **Team:**
 - *Students:* Princess Fobbs, Jouvens Blanchard, & Kalan Tucker (undergraduate, Tuskegee)
 - *Mentors:* Daniel Douglas (Ph.D. student, RPI), Stavros Konstantinopoulos (Ph.D. student, RPI), Dr. Denis Osipov (post-doc, RPI), Dr. Hantao Cui (faculty, UTK)
 - *Advisors:* Dr. Joe H. Chow (faculty, RPI), Dr. Marc Karam (faculty, Tuskegee), Dr. Greg Murphy (faculty, Tuskegee), Dr. Ben Oni (faculty, Tuskegee), & Dr. Tomsovic (faculty, UTK).

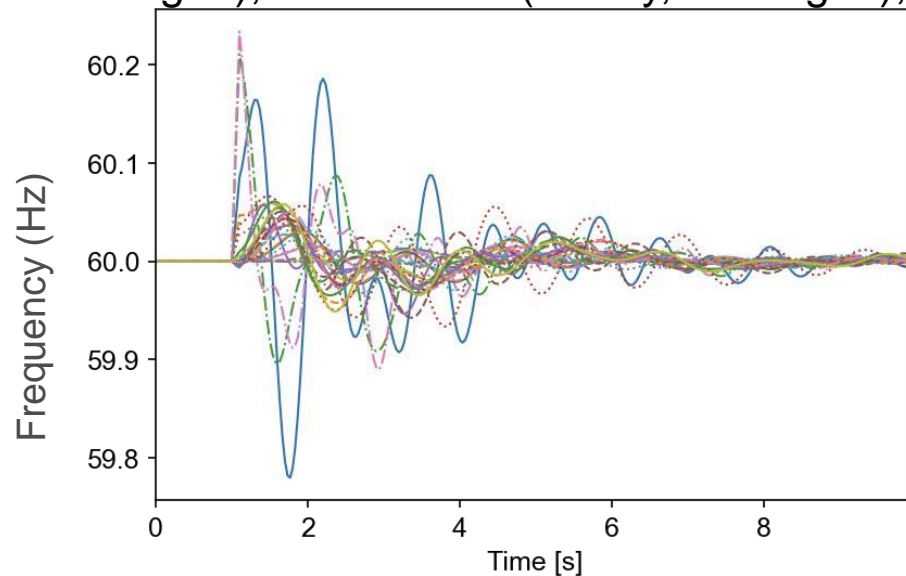


Fig. 1 N-1 stable scenario

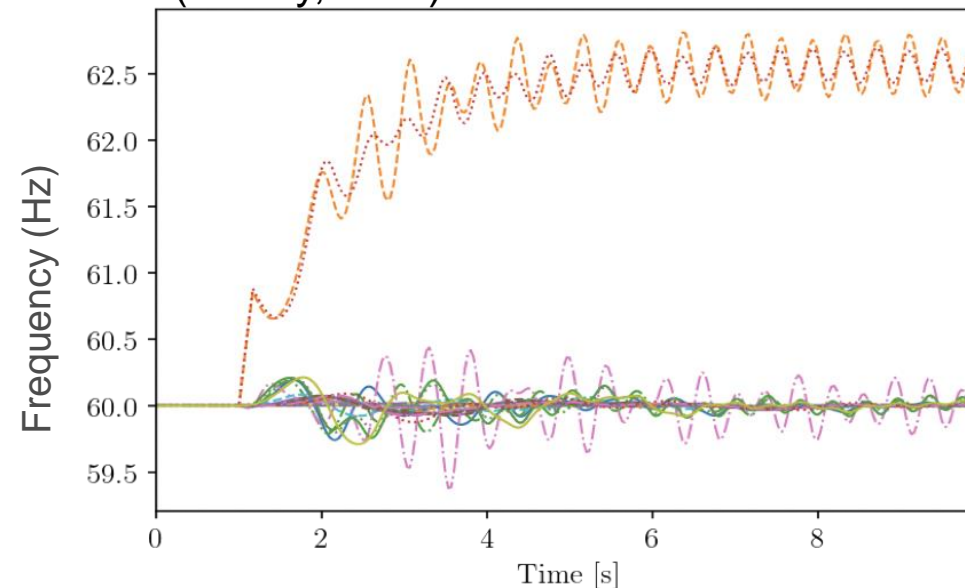
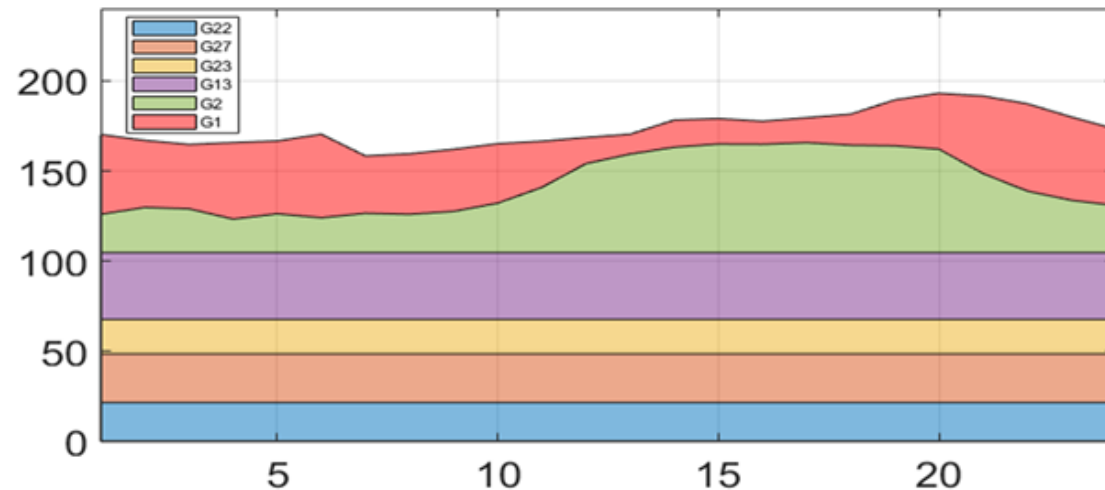


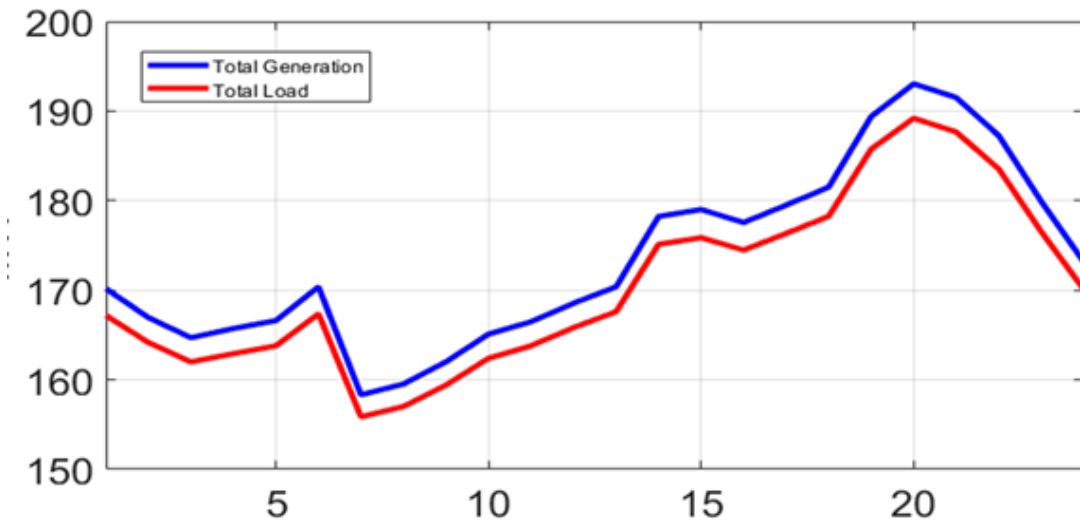
Fig. 2 N-1 unstable scenario

Example 2: Cross-campus Collaboration (TU-NEU)

- **Project:** Simulation and prediction of power system states (REU project)
- **Goals:** Perform simulations of power systems and use time series analysis tools to build tracking and prediction models for system variables of interest.
- **Team:**
 - *Students:* Quanizia Hoskins (undergraduate, Tuskegee),
 - *Mentors:* Ahmed Oner (Ph.D. student, NEU), Cesar Galvez Nunez (Ph.D. student, NEU),
 - *Advisors:* Dr. Ali Abur (faculty, NEU), Dr. Mandoye Ndoye (faculty, Tuskegee)



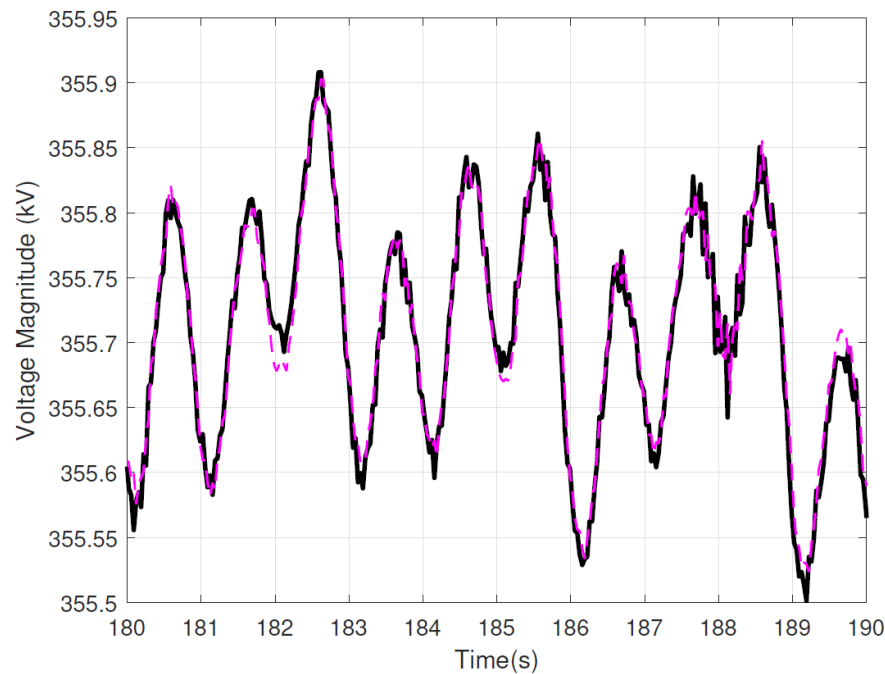
Hourly variation of certain bus loads



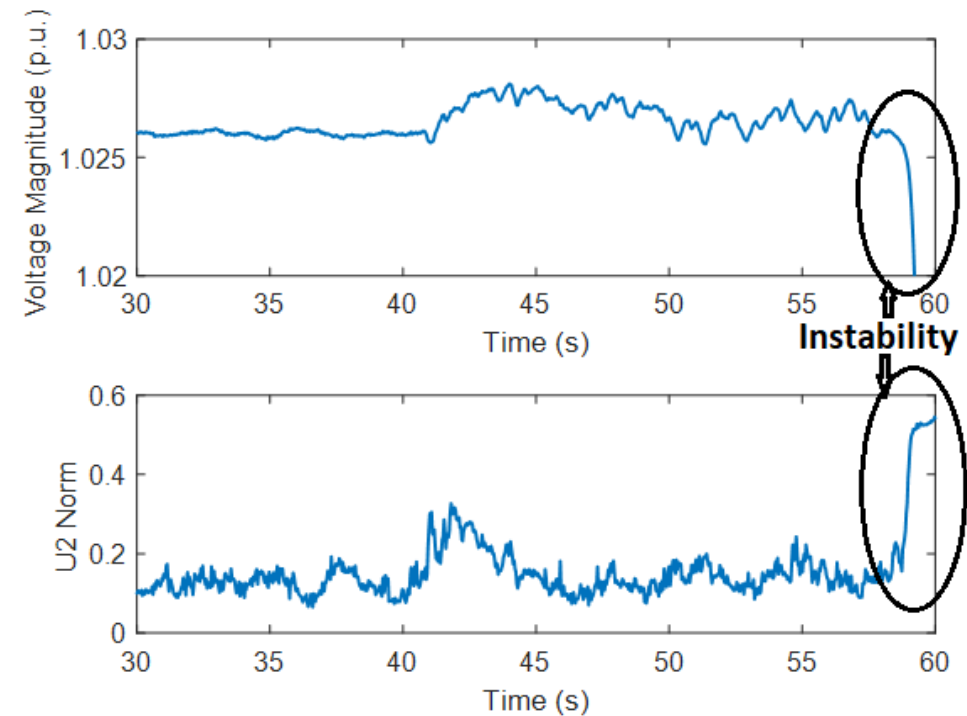
Hourly variation of total system load and generation

Example 3: Cross-campus Collaboration (RPI-NEU)

- **Project:** Synchrophasor Data Recovery via Data-Driven Filtering (graduate student research project)
- **Goals:** Develop stability limits and guarantees for data driven filter.
- **Team:** Stavros Konstantinopoulos (Ph.D. student, RPI), Dr. Chow (faculty RPI), Dr. Wang (faculty RPI), Dr. Lev-Ari (Faculty, NEU).



Stable Voltage Magnitude Recovery



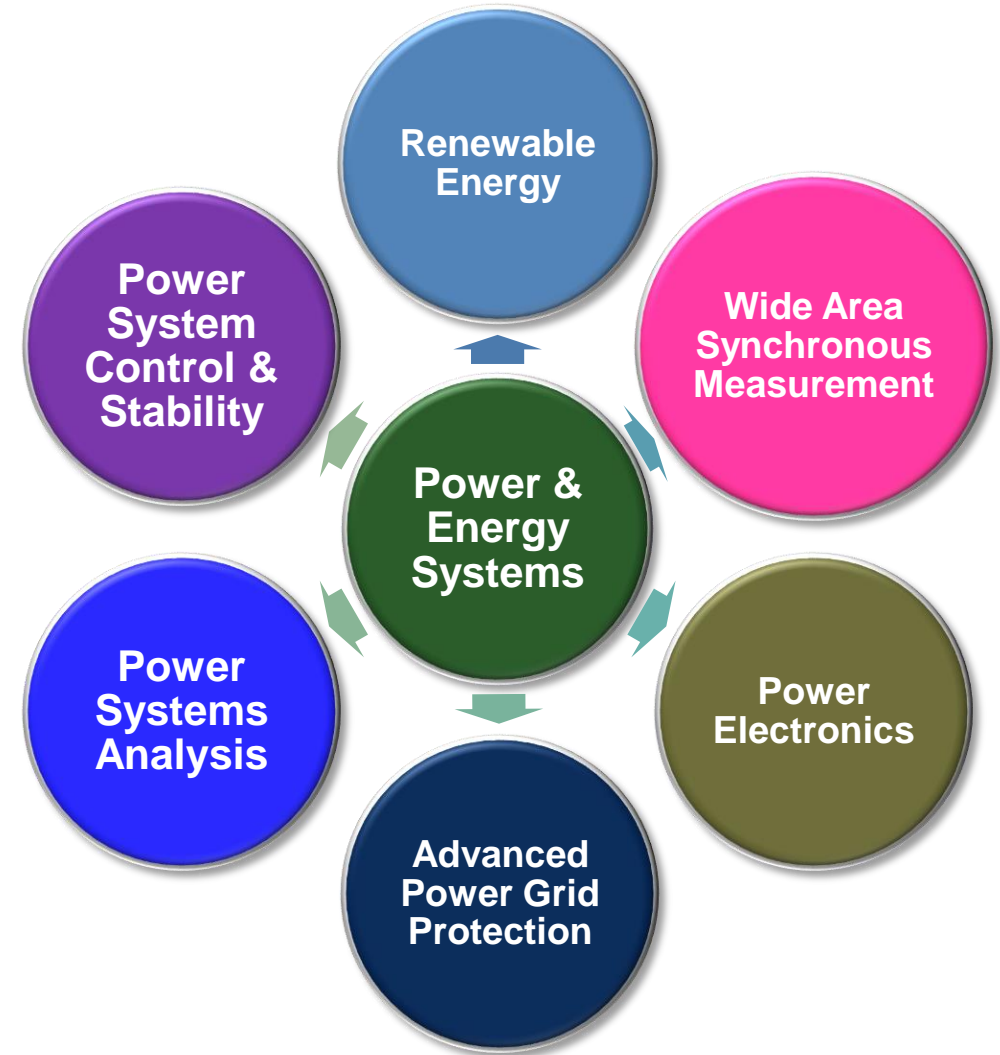
Unstable Recovery and U2 Norm Stability Metric

Interdisciplinary and Cross-Campus Collaborations

- Publications in core funding demonstrate cross-campus and interdisciplinary collaboration (total: 47)
- **7** articles co-authors with industry
- **15** co-authored with multiple engineering disciplines
- **15** co-authored with both *engineering* and *non-engineering* fields
- **28** co-authored with multiple institutions

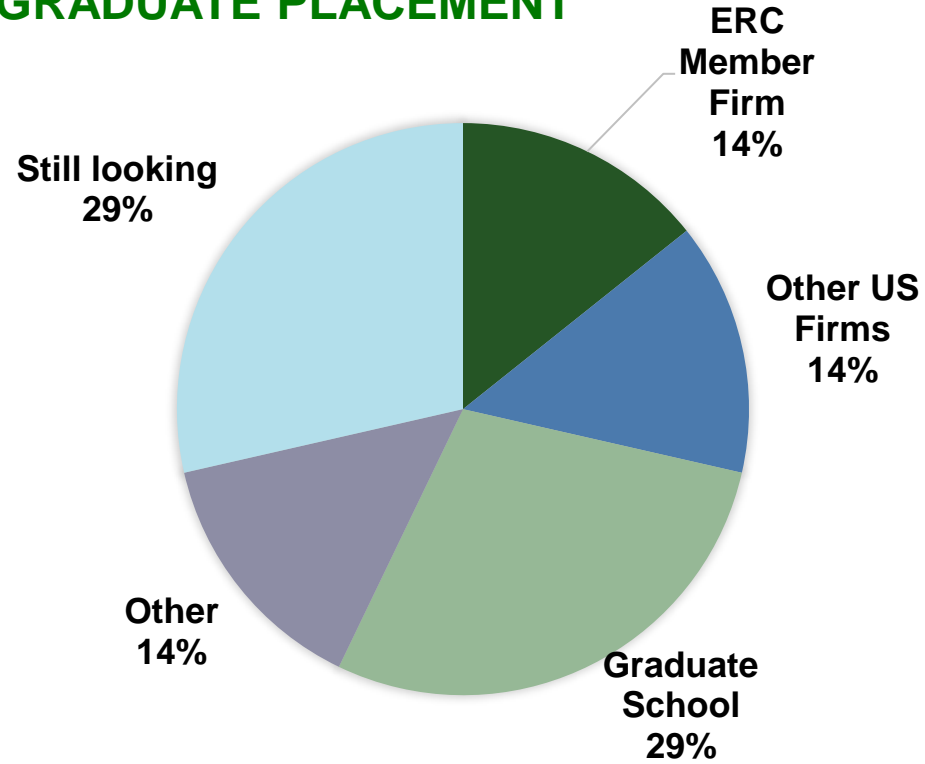
Courses and Certificate Programs

- **18** new courses
- **67** courses total as of Year 9
 - NEU simulation of EM transients course with UTK enrollment in Spring 2020
 - CURENT center-wide course offered for 9th year
 - SLC seminar offered for 9th year
- **12** undergraduate students with concentration in Power and Energy Systems
- **1** text book in Year 9
 - 4 textbooks overall

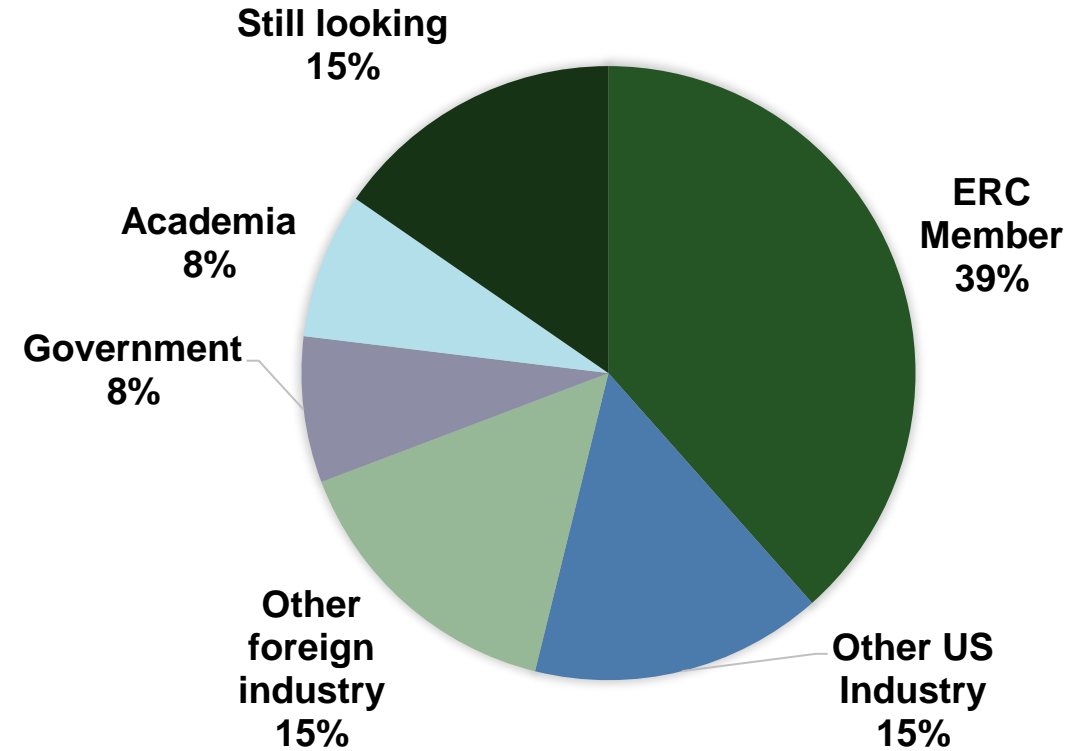


Year 9 Graduate Placement

MS GRADUATE PLACEMENT



PHD GRADUATE PLACEMENT



Undergraduate students: 1 industry, 10 graduate school, & 3 still looking

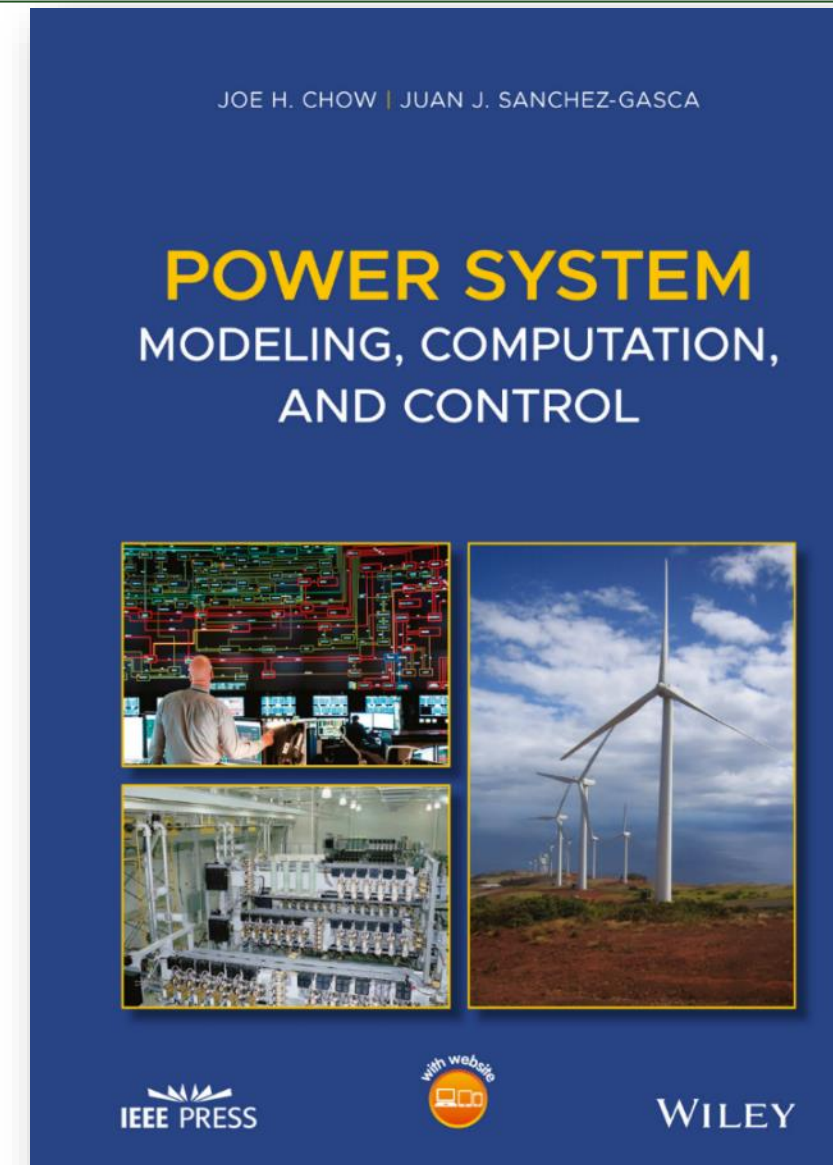
Textbook on Advanced Power System Modeling & Control

Outcome/Accomplishment

- Provides comprehensive dynamic modeling treatment of synchronous machines, FACTS controllers, HVDC systems, wind turbines, and coherency/aggregation, and voltage stability analysis.
- Includes examples and problems to perform nonlinear simulation and linear analysis, with damping control design procedures and signal selection for power system stabilizers, HVDC systems and FACTS controllers.

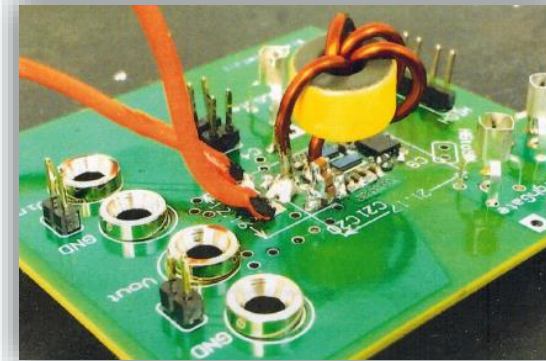
Impact and Benefits

- Useful as a reference book for practicing engineers as it covers many problems of high current interests
- A course based on the text is taught by the first author in Fall 2020 to students on-campus at RPI, and remote to UTK and Tufts University



DoE Traineeship in Wide Bandgap Power Electronics

- \$2.9 Million, 5-year DOE sponsorship – one of only two awardees in the nation
- **27** US citizens (10 are in program now, 17 received M.S. degree)
- Hands-on training for US citizens
- Program-specific goals
 - Recruit diverse, domestic graduate students
 - Expand MS thesis program
 - Develop hands-on coursework
 - Comprehensive research and professional training of future power electronics workforce
- 7 courses offered in 2019-20
- Companies (ABB, Danfoss, GE, Cree/Wolfspeed, TI, Boeing, Intel, VW) or ORNL mentors provide weekly/monthly/quarterly feedback.
- Graduates working in power electronics fields (e.g. Raytheon, SF Motors, Texas Instruments)

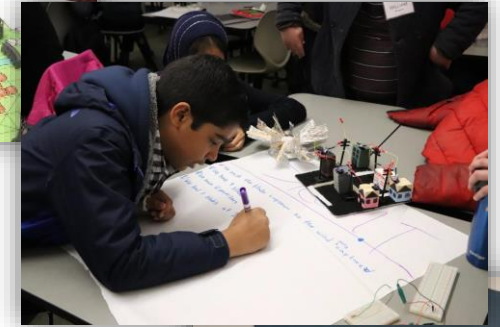
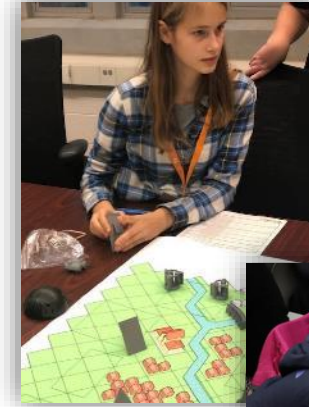


DOE Visits PoTenntial

PRECOLLEGE PROGRAM

Pre-College Education Program Highlights

- 3 RETs participated in the virtual program
- 7 Young Scholars participated in CURENT virtual program
- **Outreach: 8** classroom visits; **4** Family Engineering Night (UTK), **1** STEM night partnerships (UTK), **6** Saturday morning events with non-profit Rise High (RPI)
- Nearly **200** teachers and **4000** students attended CURENT outreach events during Year 9
- RPI partnered with the Troy Boys and Girls Club to distribute STEM kits to students receiving food during the NY State lockdown during the pandemic
- UTK continued partnership with Project Grad at spring Urban Brilliance event
- RPI continued partnership with Rise High and increased classes from 3 to 6



From top to bottom:
Expanding Your Horizons;
Rise High;
Family Engineering Night at Spring Hill Elementary

Virtual Young Scholar Program (YSP)

Research Training

- Programming and research skills
- Basic power & energy engineering knowledge
- Interdisciplinary aspect of energy

Research Projects

- One-on-one mentorship
- Team projects
- Poster and presentation sessions

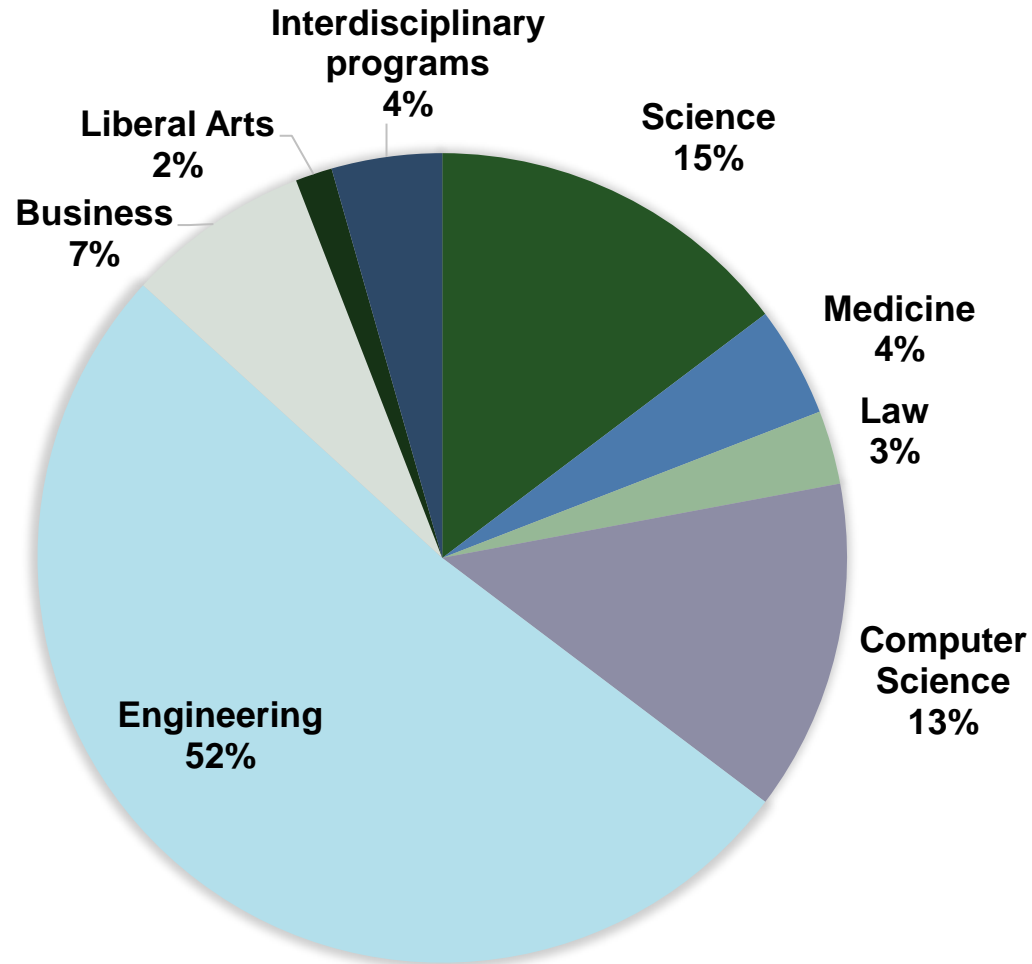
Career Knowledge

- Industry and academic career awareness
- Professional training

YSP projects:

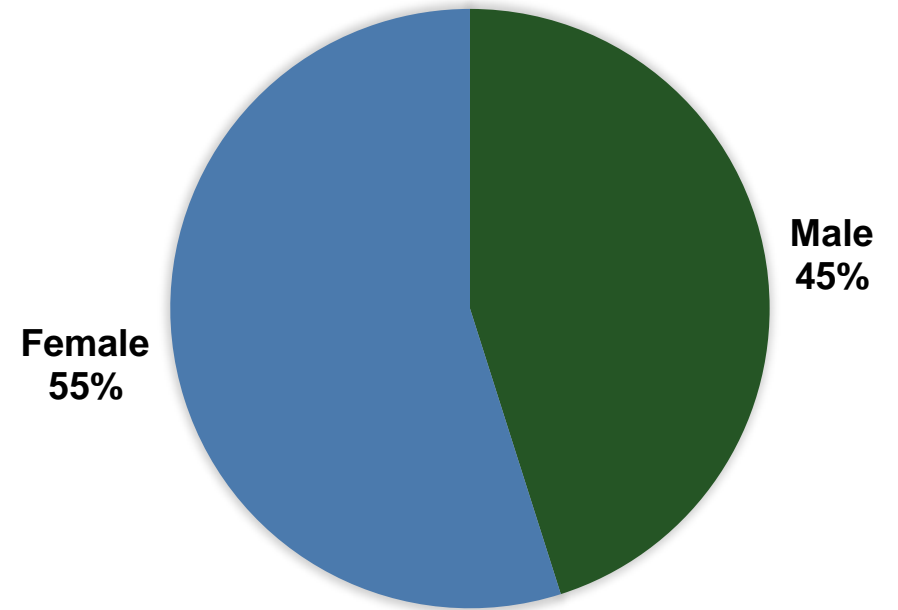
- Human Factors and Ergonomics to Combat Covid-19 in Workplaces
- Perceived Energy Use and Personal Norms during COVID-19
- Analysis of Multi-Faceted Factors Influencing Solar Energy Adoption from an Interdisciplinary Angle
- Following your Heart(beat)

Year 1-Year 9 YSP Longitudinal Tracking



YSP COLLEGE MAJORS

Y1-Y9 PARTICIPANTS

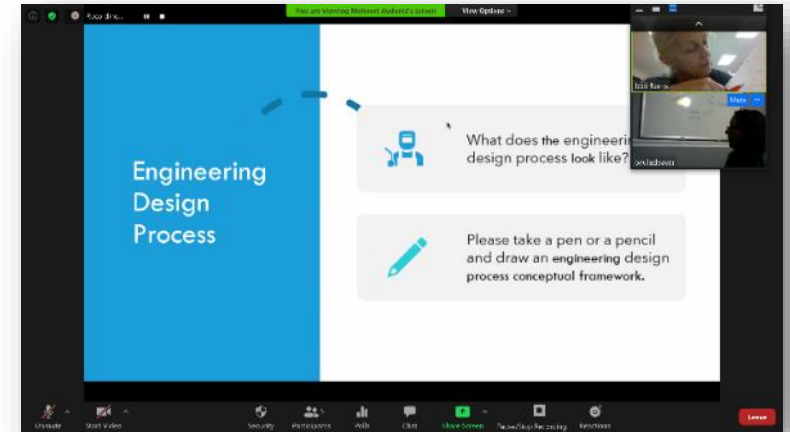


• Total 107 YSPs

Virtual Research Experience for Teachers (RET)

RET projects

- Three teachers from underserved schools
- **Rural:**
 - Jodi Burns (Bakersfield Middle School, MO), *All Aboard with Conductors*
 - Paula Deaver (Horace Maynard Middle School, TN) *Structure of the Atmosphere*
- **Urban**
 - Michael Fugate (Putnam City West High School, OK) – *Mac the Toucan: Renewable energy and engineering design*



Top: RETs discussing the Engineering Design Process with Dr. Mehmet Aydeniz from Theory and Practice in Teacher Education, UTK;
Bottom: RET Michael Fugate's wind turbine design



Family Engineering Night

Five events

- 696 students attended in Y9
- Planned 4 elementary school events
- Attended 1 elementary school event as presenters

Popular stations include

- Playdoh circuits
- Wind turbines
- Aerodynamic racing

Notable highlights

- Added new schools with underserved populations
- Partnered with Society for Women in Engineering (SWE) and Jones Center for Leadership at UTK



Above: Family Engineering Night at Amherst Elementary

Below: Teachers and CURENT volunteers are Powell Elementary Family Engineering Night



Classroom Visits



Boomerang of wind turbine at Powell Elementary School, TN

Classroom Visits

- RPI Engineering Ambassadors visited 5 middle and high schools to teach programs on the Grid, Wind Generation, and Thermoelectric Devices to 1880 students.
- UTK visited Powell Elementary, a rural school in Knoxville. 161 students built and tested wind turbines while learning about renewable energy and the engineering design process.

Lab Tours, Workshops and Campus Visits

Campus Activities

- At UTK, **60** students from Emmett Elementary School built wind turbines and learned about socio-economic impacts of renewable and non-renewable energy generation through VOLt City Activity
- Partnered with NIMBioS for a middle school girls event, *Expanding Your Horizons* with **53** participants from across Tennessee
- NEU continued to host the Building Bridges program, which included **15** students from 7 high schools across the state of Massachusetts

Workshops

- RPI held a Solar Build workshop in Nigeria for **25** high school students



From top to bottom:
Solar Build workshop
in Nigeria; Building
Bridges at NEU;
Expanding Your
Horizons at UTK

Community Outreach



Above and Below:
CURENT at Project GRAD Urban Brilliance



Project GRAD

- Second year participating in Urban Brilliance event in March
- Made Playdoh circuits and robots with 200 elementary and middle school students from urban schools

Troy Boys and Girls Club

- RPI Engineering Ambassadors created STEM boxes to be distributed with food donations at the Troy Boys and Girls Club during the NY State lockdown this spring
- 400 students each week received kits for several weeks

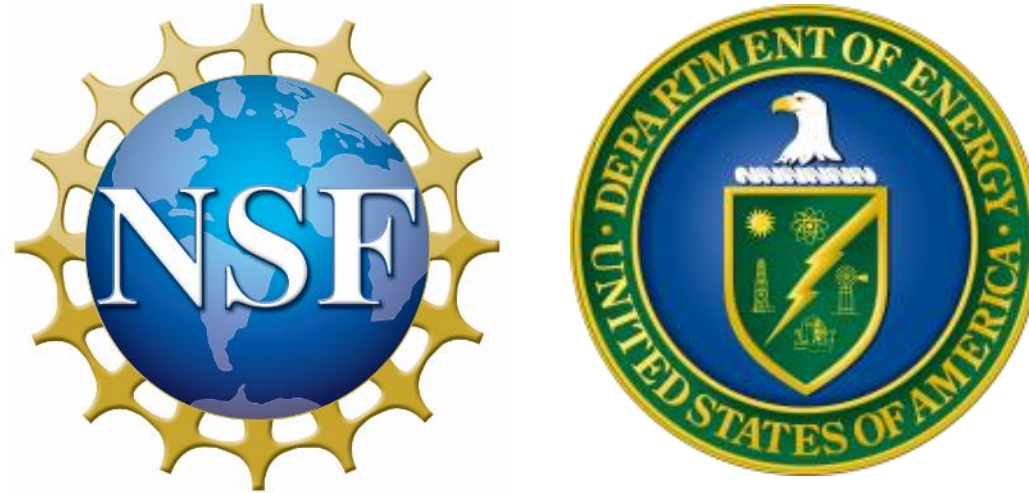
Selected Plans for Year 10

University Programs	<ul style="list-style-type: none">▪ Continue to provide professional training and inclusion workshops to students across all schools▪ Shared seminars and courses to strength collaboration▪ Continue onboarding meeting each semester▪ One-on-one mentorship (student and faculty) as well as first-year graduate student mentorship▪ Evaluate COVID-19 impacts on student learning
Precollege Programs	<ul style="list-style-type: none">▪ Expand RET through collaboration with Tickle College of Engineering Office of Diversity Programs▪ RPI Engineering Ambassadors organization to offer training for Tickle College of Engineering Outreach Ambassadors (new college-wide program started Fall 2020)▪ Young Scholars Program<ul style="list-style-type: none">▪ Institutionalized into Tickle College of Engineering, UTK

Selected Plans for After Year 10

University Programs	<ul style="list-style-type: none">▪ First and second year graduate student development plans▪ Increased students cross-campus and disciplinary collaboration including exchanges when feasible▪ REU program institutionalized at UTK, NEU, RPI▪ Seek additional education funding▪ Diversity and inclusion institutionalized and leveraged with UTK TCE diversity and inclusion plan
Precollege Programs	<ul style="list-style-type: none">▪ RPI Solar Build Summer Camp institutionalized at RPI with future roll-out at other schools▪ Education and Outreach Coordinator position institutionalized at UTK, continue to leverage all campuses' education efforts<ul style="list-style-type: none">▪ CURENT RET curriculum being integrated in UTK TCE outreach activities▪ Family Engineering Nights, YSP and middle school girls camp institutionalized at UTK

Acknowledgements



This work was supported primarily by the ERC Program of the National Science Foundation and DOE under NSF Award Number EEC-1041877 and the CURENT Industry Partnership Program. Special thanks to Emerson, Sequoyah Elementary, Spring Hills Elementary, Powell Elementary, Rise High!, and others.

Other US government and industrial sponsors of CURENT research are also gratefully acknowledged.

Questions and Answers

(Questions from NSF/DOE Site Visit Team first)