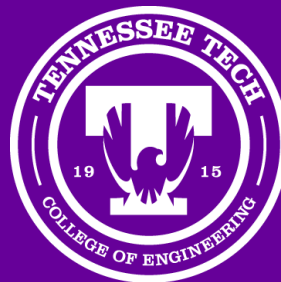
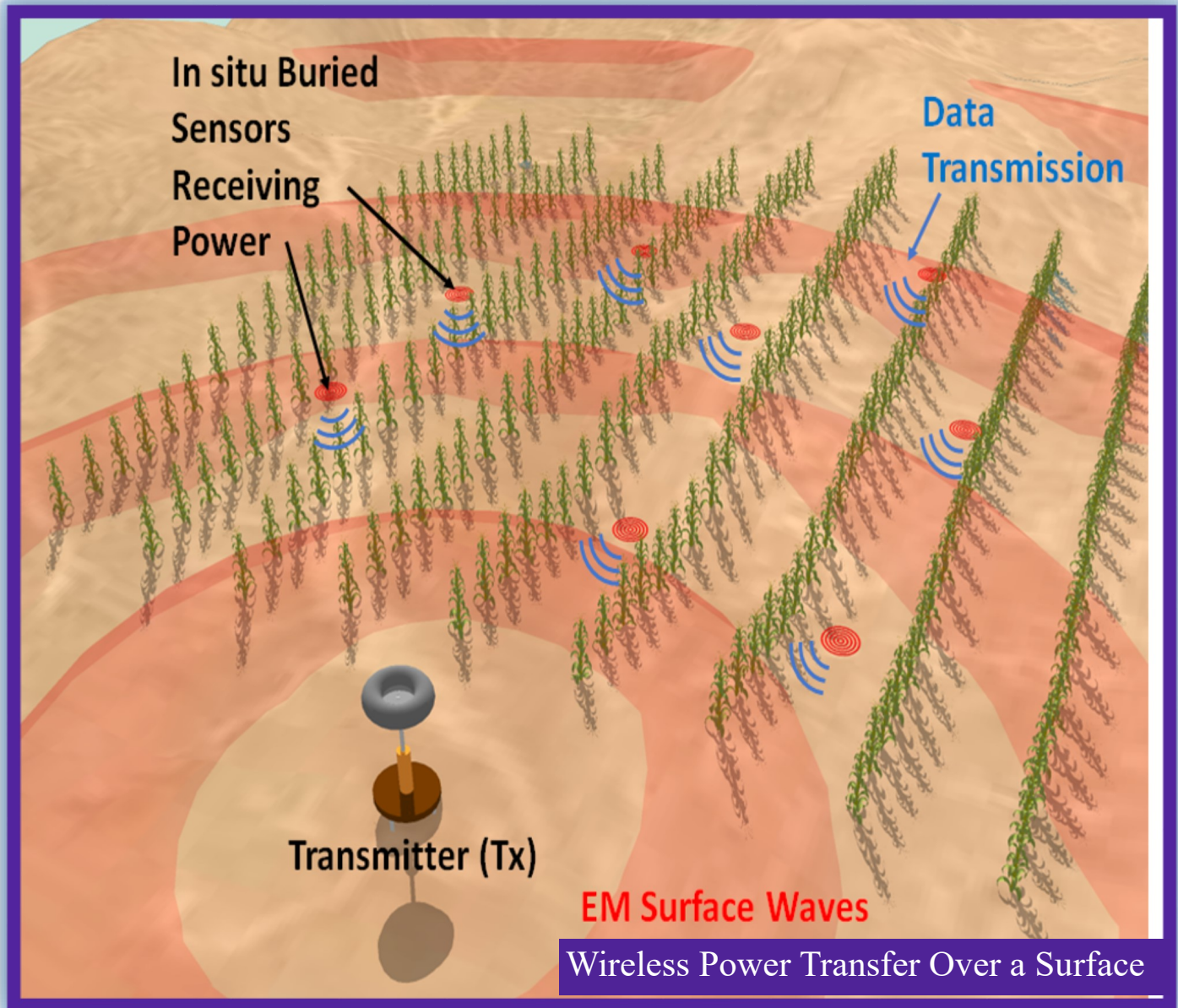


# Center For Energy Systems Research Tennessee Tech University

Annual Report for Fiscal Year 2019-2020



# Annual Report for Fiscal Year

July 1, 2019—June 30, 2020

Satish M. Mahajan, Director

[www.tntech.edu/cesr](http://www.tntech.edu/cesr)



Center for  
Energy  
Systems  
Research

*“Where research is put into practice.”*



**Tennessee**  
**TECH**

# Center for Energy Systems Research

1020 Stadium Drive, PRSC 233

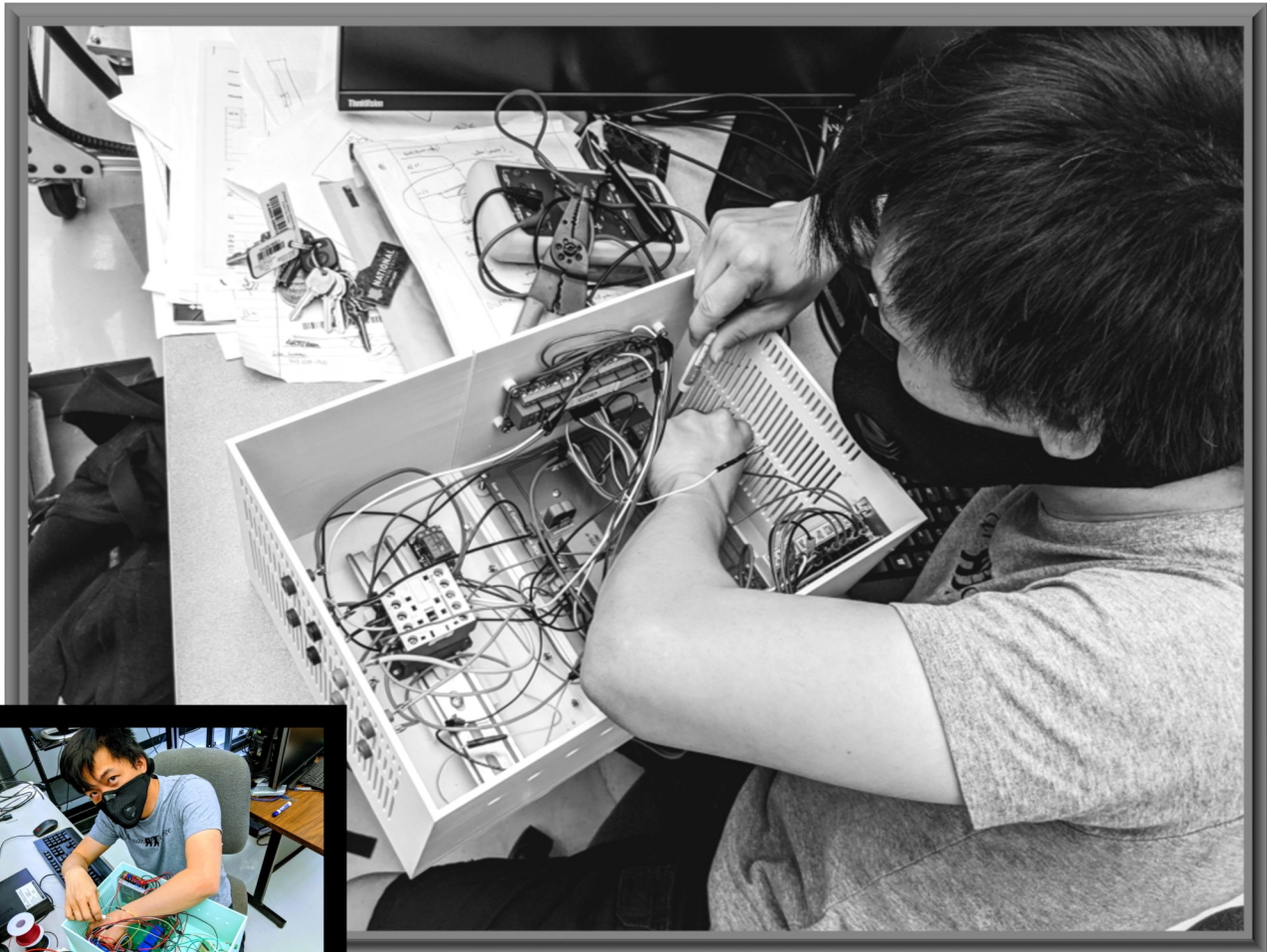
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Master's Student, Quy Ton Le, working on a generator controller for the scale-model smart grid.

# TABLE OF CONTENTS

## PROGRAMMATIC REPORT

MISSION .....	1
VISION .....	1
HISTORY .....	1
YEAR IN REVIEW .....	2
RESEARCH AREAS 2019-2020 .....	3
CESR RESEARCH FUNDING 1985 THROUGH 2020 .....	3
WINGS UP AWARD RECIPIENTS.....	6
FACULTY AWARDS AND ACCOMPLISHMENTS 2019-2020 .....	7
STUDENT AWARDS AND ACCOMPLISHMENTS 2019-2020 .....	8
PLANS FOR 2020-2021 .....	12

## SUPPORTING MATERIALS

SUPPORT STAFF	SM-1 .....	14
FACULTY PARTICIPATION	SM-2 .....	15
CONTRACT AND GRANT AWARDS	SM-3 .....	16
PROPOSALS	SM-4 .....	27
PUBLICATIONS OF CESR FACULTY	SM-5 .....	38
BOOK/CHAPTER/PATENTS OF CESR FACULTY	SM-6 .....	39
SEMINAR SERIES	SM-7 .....	40
CESR GRADUATES	SM-8 .....	42
GRADUATE STUDENT SUPPORT	SM-9 .....	47
HOURLY STUDENT PERSONNEL	SM-10 .....	50
UNDERGRADUATE RESEARCH PROJECTS	SM-11 .....	53

## BUDGET MATERIALS

ACTUAL, PROPOSED, AND REQUESTED BUDGET—SCHEDULE 7 .....	60
JUSTIFICATION FOR 2020-2021 APPROPRIATIONS REQUEST .....	61



# PROGRAMMATIC REPORT

## **MISSION**

The Center for Energy Systems Research (CESR) was established to advance and apply scientific and engineering knowledge associated with energy systems and in particular with electric power while supporting the instructional program of Tennessee Technological University (TTU) in academic areas associated with energy systems. During the College of Engineering Strategic Planning of 2012-13, two strategic research areas, Smart Grid and Resilient Infrastructure, were assigned to the Center for Energy Systems Research as focus areas of research. Present research efforts, both theoretical and experimental, are focused on solving current and anticipated problems associated with energy and infrastructure systems. Special emphasis is given to the needs of the electric power industry by way of conducting research on Smart Grid.

## **VISION**

The Center will be known and be recognized nationally for its research contributions in Energy Systems and Infrastructure areas.

The Center's vision is to enhance research and education in support of its mission. The Center will conduct advanced and applied research to enhance knowledge in currently needed and emerging technical areas of Energy and Infrastructure Systems. The Center also has major interests in the dissemination of knowledge and enhancing education in energy systems.

The Center draws upon the expertise from the faculty in the College of Engineering as well as from other faculty on campus. Participating faculty and faculty associates represent Basic Engineering, Chemical Engineering, Civil and Environmental Engineering, Computer Science, Electrical and Computer Engineering, Mathematics, Mechanical Engineering, Manufacturing and Engineering Technology, and Physics.

## **HISTORY**

The State of Tennessee established the Center for Electric Power in 1985 in the College of Engineering at Tennessee Technological University. Reflecting the broadening of the activities of the Center, its name was changed to Center for Energy Systems Research. Over the years, research projects have been sponsored by more than 20 major electric utilities, EPRI, federal agencies such as DOE, NASA, NSF, and ONR, State agencies such as TDOT and Tennessee Department of Education, and industries such as Buswell Energy.

In the 2012-2013 academic year, the College of Engineering identified six strategic research areas in which to focus the research efforts of its faculty and students. Of the six areas, CESR chose two areas, namely, 1) Smart Grid and 2) Resilient Infrastructure to focus its research. Development of large collaborative research proposals will be encouraged in these areas.

To promote the research and innovation, CESR provides services of an R&D Engineer, Financial Analyst, Financial Associate, and Administrative Associate in support of the various research activities performed by faculty and students. The Center has set up laboratories and computational resources for the benefit of researchers.

The Center promotes international collaboration by hosting visiting scholars, scientists and engineers and establishing Memoranda of Understanding with international academic institutions and research organizations.



Dr. Satish M. Mahajan continued as the Director of the Center for Energy Systems Research (CESR) for fiscal year 2019-2020. The CESR continues to focus on two strategic research areas of the College of Engineering: Smart Grid and Resilient Infrastructure. In addition, the CESR has taken major strides towards ‘wireless power transfer’ as a new area of research.

2019-2020 was another good year for the CESR. This year, the external funding has increased slightly (~5% over last year’s record funding) for a total of \$2,361,707, making 2019-2020 another record-breaking year in the 35-year history of CESR. It certainly represents the extra energy put in by the Center faculty associates and the extra support given to them by the Center staff. It is only the fourth time since 1985 that the CESR activations have crossed \$2 million.

This year’s 51 proposals submitted by the CESR faculty associates amount to about \$11.6 million. Hopefully, this increased number of proposals will help CESR sustain activations over \$2 million per year and possibly go beyond. It is important to keep these efforts—even with the additional burden of performing the research—particularly in view of TTU’s Carnegie Classification (R2) that requires a sustained growth of doctoral students. The CESR’s momentum lines up very well with the TTU President’s vision of doubling the external funding/activations by 2025. While benefits to the students’ education are of primary interest, benefits to the State of Tennessee are bound to increase as a result of long-term investments made by the State.

In the 2019-2020 fiscal year, the CESR funded 24 M.S. assistantships, (4 on grants only; 5 on CESR only; and 15 on grants, CESR, and other University sources); and 17 Ph.D. assistantships (5 on grants only; 7 on CESR only; and 5 on grants, CESR, and other University sources), representing a significant commitment to improve the research efforts at TTU. The CESR supported a total of 70 graduate students on an hourly basis. The CESR also supported 39 undergraduate students, a significant number of them on the grants.

For the last 3 years, the ‘wireless power transfer’ efforts in the CESR were led by Dr. Charles Van Neste. He will be starting his tenure-track appointment in the ECE Department at TTU in August 2020, but we look forward to his continued efforts and interaction with the CESR, and wish him well! The wireless power transfer area received major funding from the U.S. Army (ERDC) via MSU, NASA, NSF, and TVA.

Dr. Shirin Noei is joining the CESR in August 2020 and is expected to strengthen our resilient infrastructure group through her expertise in the transportation area.

The involvement and success of new CSC faculty in the NASA project is commendable. The CESR is once again committed to four new faculty—two each in the ECE and ME departments. We look forward to their contributions to the research activities of the CESR in the upcoming years.

COVID-19 presented a unique challenge to the experimental researchers of the CESR. We do hope to see the end of the pandemic very soon. The long-term impact on our research remains to be seen.

**PROGRAMMATIC REPORT**

Research contract and grant awards included in Matching from July 1, 2019 thru June 30, 2020 total \$1,873,382.20. Gifts and Other Awards included in Matching total \$5,430.00. Therefore, the 2019-2020 Match is \$1,878,812.20. Indirect costs of approximately \$482,895.76 were also received during the 2019-2020 Fiscal Year. The result is that the 2019-2020 Matching and Indirect Costs total \$2,361,707.96. The State Appropriation was \$970,600.00 for 2019-2020.

CESR continues to enjoy a broad base of support. The funding categories for 1985 thru 2020 as illustrated in Figure 1 are: in-state utilities, 9.78 percent; out-of-state utilities, 5.31 percent; state and local agencies, 9.04 percent; federal government, 61.73 percent; other, 14.14 percent. The “other” category includes a variety of national and international industries, universities and professional societies. Through June 2020, the cumulative research funding of the Center is \$35,041,124.85. State appropriations are compared to matching, on an annual basis, in Figure 2. Matching is divided into contracts and grants (without indirect costs); equipment; and all other items such as software, books and reports, and funding for faculty and student exchange programs. The 35-year match of about \$33.4 million represents 106.72% percent of the state appropriations of \$31.3 million. Indirect costs of approximately \$6.2 million were also received. A list of the projects conducted under the major research areas is given in SM-3 in this report.

**CESR RESEARCH FUNDING 1985-2020**

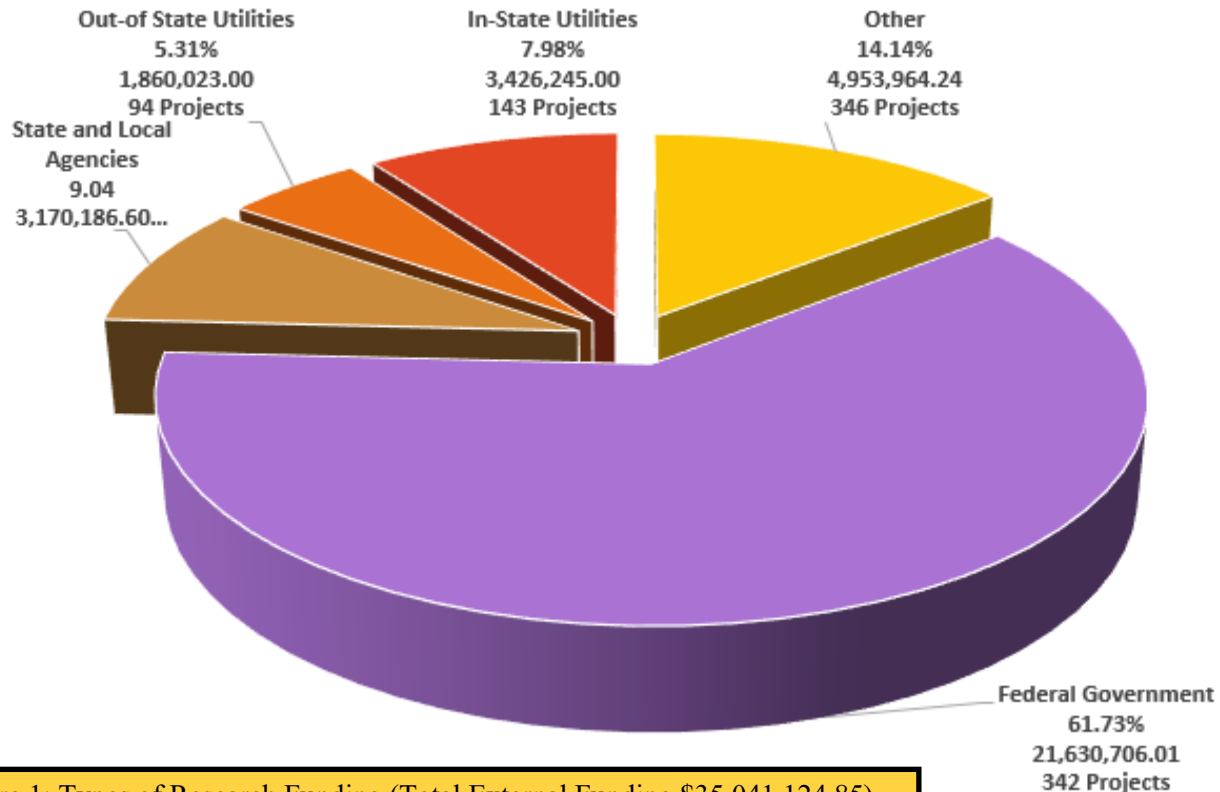


Figure 1: Types of Research Funding (Total External Funding \$35,041,124.85)

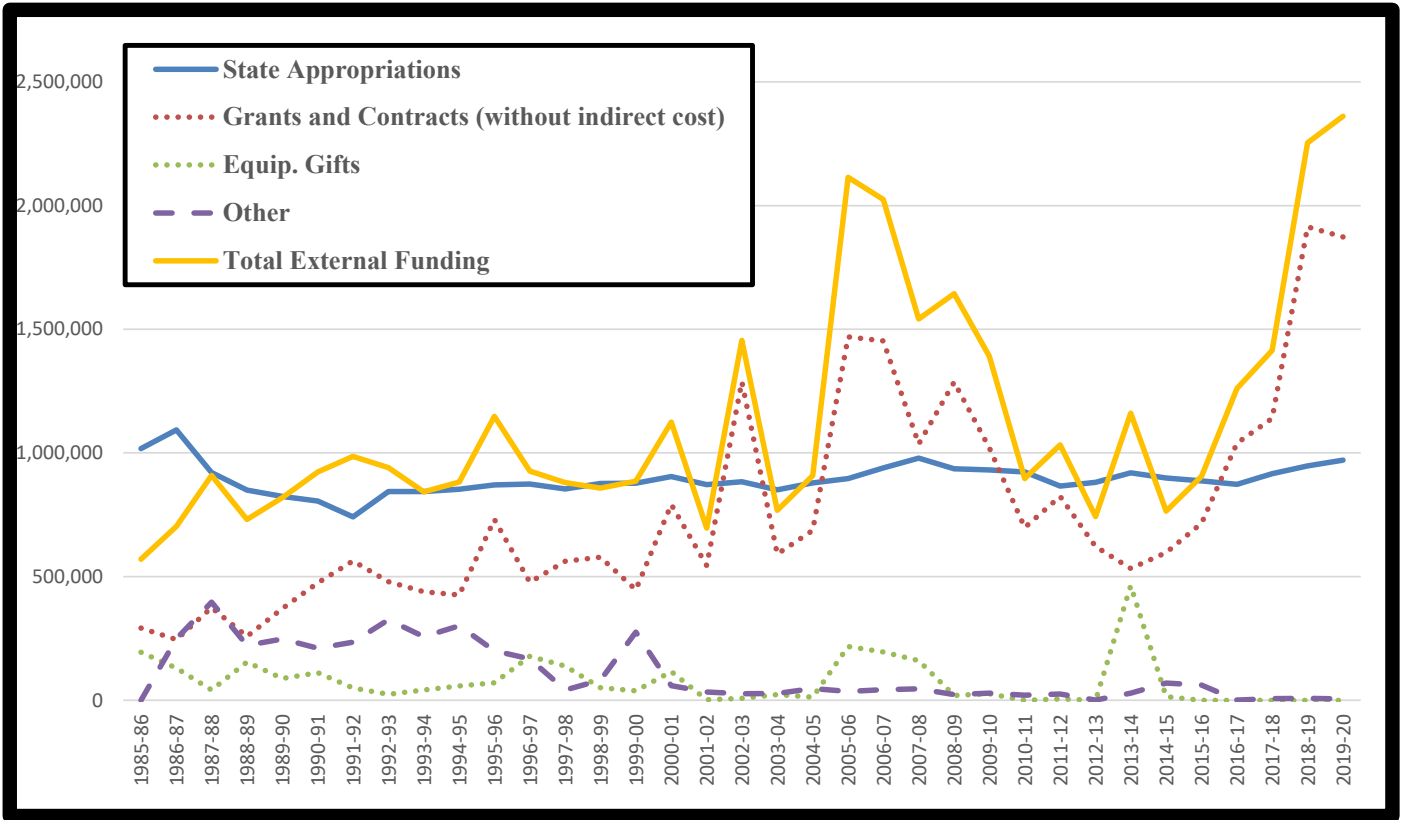


Figure 2: Historical State Appropriations, Matching, & Total External Funding 1985-2020



Center for Energy Systems Research  
(Number of Students Supported Financially)

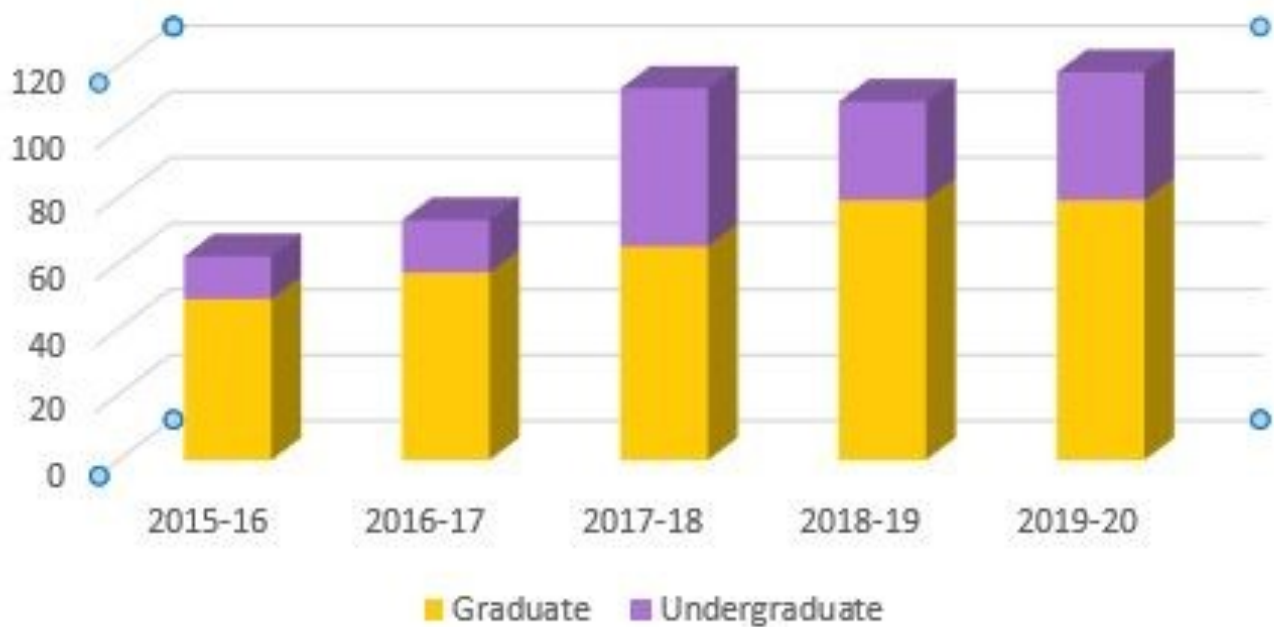


Figure 3: Number of Students Supported.

The Wings Up 100 Research Achievement Award is given to Tennessee Tech faculty members who have activated at least \$100,000 in external grants. We are pleased to report that the following CESR faculty associates received this award for their accomplishments in the previous fiscal year (2018-2019). The awards were given in the month of September, 2019.

- ♦ Dr. Indrinal Bhattacharya, Associate Professor, ECE
- ♦ Dr. Sheikh Ghafoor, Professor, CSC
- ♦ Dr. Mohamed Mahmoud, Associate Professor, ECE
- ♦ Dr. Mustafa Rajabali, Associate Professor, Physics
- ♦ Dr. Ambareen Siraj, Director of CEROC and Professor, CSC
- ♦ Dr. Charles Van Neste, Research Assistant Professor, CESR



Dr. Mohamed Mahmoud, ECE Associate Professor, has received the following:

- ♦ Best Paper Award : W. Al Amiri, M. Baza, K. Banawan, **M. Mahmoud**, W. Alasmay, K. Akkaya, “Privacy-preserving smart parking system using blockchain and private information retrieval,” *Proc. of the 2019 International Conference on Smart Applications, Communications and Networking (IEEE SmartNets)*, Dec. 2019.
- ♦ Appointed as an Associate Editor for *IEEE Internet of Journal (IoT)*. 2020-present
- ♦ Recipient of the Kinslow Engineering Research Award, Tennessee Tech University , 2020. This award is given annually for the best paper written by a TTU engineering faculty member and published in a peer-reviewed professional journal. The selection criteria include both research innovation and research applicability.



Above left:

Front (L-R): Terrie Askey, Jr., Viviana Cruz, Mohera Narimetla, Jennifer Toney, Dr. Jessica Oswald, Associate Dean, COE (TLSAMP PI).

Back (L-R): Harry Ingle, Director of Diversity, Recruitment, Student Success, COE (TLSAMP Site Coordinator); Triston Whitescarver, Darius Eury, Joshua Egwatu, Jymon Scott, Jaron Mack.

Above right:

Chemical Engineering students Viviana Cruz (on left) and Mohera Narimetla at the TLSAMP Conference at UT.

Viviana worked with Dr. Holly Stretz on REU in Summer 2019. Her undergraduate research was about Li ion recovery from brines for batteries. She won 2nd place in the oral competition.

Mohera does research with Dr. Joe Biernacki. She won 1st place in the poster competition.

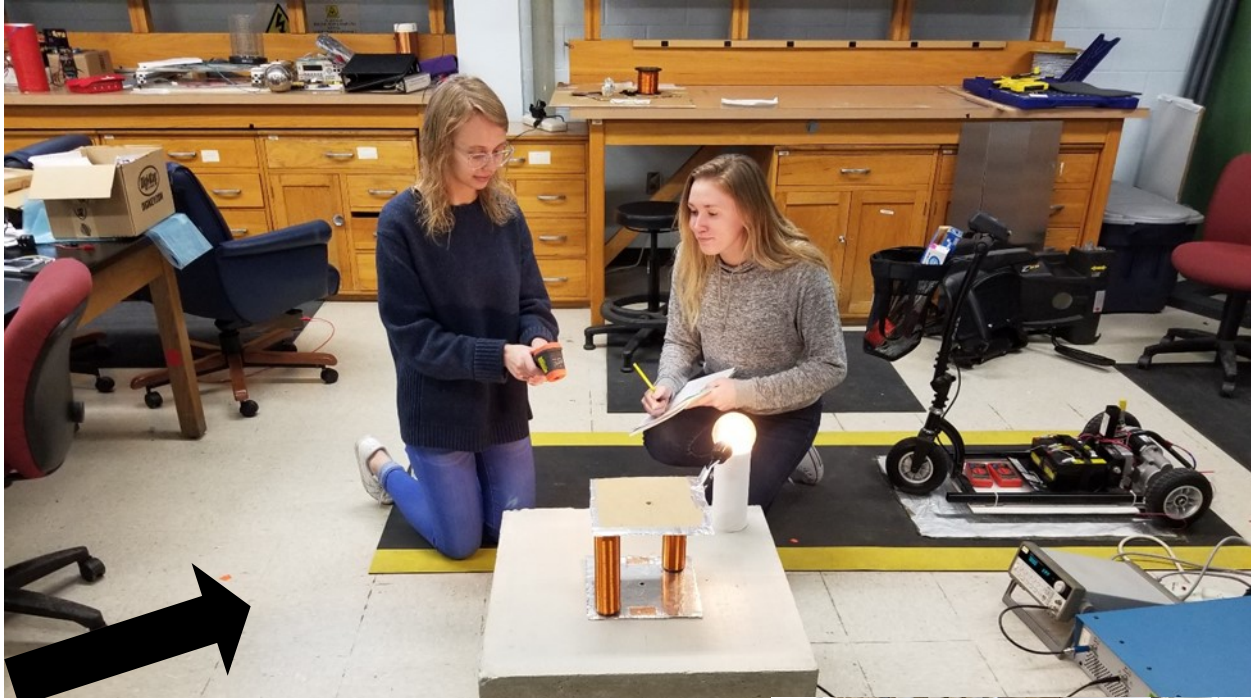


Students of Dr. Indranil Bhattacharya, ECE, were winners of the following awards:

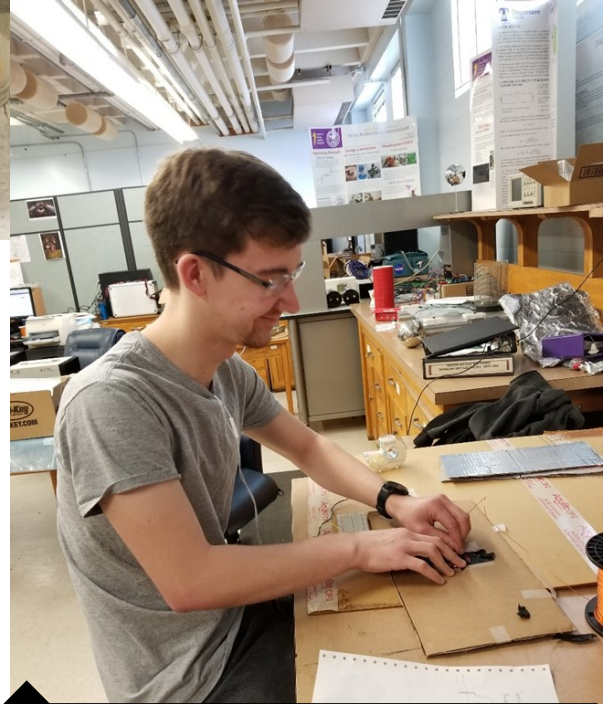
- ♦ Muhammad Bima, Ph.D. Student, Best Research Award, Annual Student Research and Creative Inquiry Day for 2020, Tennessee Tech University
- ♦ Muhammad Bima, Ph.D. Student, Best Ph.D. Research Paper, Electrical and Computer Engineering, 2020, Tennessee Tech University
- ♦ Eungkyun Kim, Undergraduate Student, Best Research Award, Annual Student Research and Creative Inquiry Day, 2020, Tennessee Tech University

Students of Dr. Syed Rafay Hasan, ECE, won the following:

- ♦ Jacob Nelson (primary author) and Tolulope Odetola (co-author) won Best Poster Award for Graduate (MS) Students, Annual Student Research and Creative Inquiry Day, 2020. The title of their poster was: WORDA:A “6/3” Winograd OfflineRuntime Decomposition Algorithm for Faster Inference



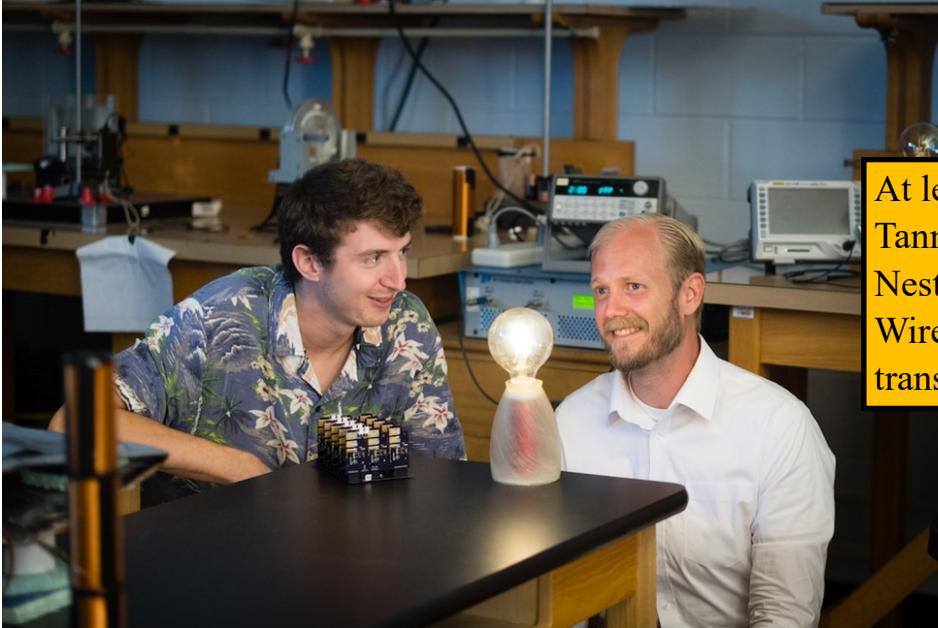
Undergraduate Students, Maci Arms and Kayla Truman-Jarrell, are shown taking measurements on the effects of high frequency on concrete.



Master's Student, Tyler Marcrum, is shown building a WPT experimental setup.



Undergraduate Student, Whitney Kirby, is shown experimenting with Capacitive Wireless Power Transfer System



At left: Master's Student, Tanner Mingen, and Dr. Van Neste demonstrate Quasi-Wireless Capacitive Power transfer.



At right: Master's Student, Charles Robinson, and Dr. Van Neste are shown demonstrating Through-the-Soil power transfer research that is currently funded by the National Science Foundation.





## PLANS FOR 2020-2021

### Increase Research Activity in the Areas of the Center

Generate external funding that will contribute to the long-term growth and sustainability of the Center. As a minimum, the external funding generated per year by the center should match the state funding. Efforts will be made to sustain \$2 million level.

Center faculty and the R&D Engineer will produce at least five publications in total. Once sufficient data is collected, it will be reported on a running three-year average to smooth differences between publication timing and research project timing.

The Center Focus Areas also intersect the University Flight Plan focus areas to Create Distinctive Programs and Invigorate Faculty. In addition to hosting meetings for each research area to promote collaboration and proposal writing, the Center has initiated several seminars to kick start collaborative research efforts and energize faculty efforts, these efforts will be continued in the next year.

### Increase Student Research Activity

Continue pursuing support to the MS and Ph.D. graduate students in the strategic research areas of the Center consistent with the level of external funding.

Support at least two undergraduate research projects per year in the areas related to energy systems.

This goal intersects the University Flight Plan's New Graduate Programs sub goal.

### Increase Collaborative Research

Continue pursuing the development and submission of two collaborative proposals with interdisciplinary focus. The number of collaborative proposals submitted should be at least two per year.

This goal intersects the University Flight Plan's Multidisciplinary Research Innovation sub goal.

### Add Laboratory Facilities

Continue to support the development of the wireless power laboratory. Two additional deep drills will be made in the field to be able to focus power.

This goal intersects the University Flight Plan's Physical Infrastructure Priorities sub goal and the Technology Service to Students sub goal, and the Technology in Teaching sub goal. Better facilities in areas of national importance like the Smart Grid benefit research, education, and hire-ability of our graduates.

### Increase Outreach Activities

Assuming COVID-19 pandemic ends soon, organize a minimum of two seminars by external speakers per year.

This goal intersects the University Flight Plan's Co-Curricular Undergraduate Program sub goal and the Multidisciplinary Research Innovation sub goal. By having research area experts from outside the university come teach seminars, workshops or short courses, the students will be exposed to a broader base of information and hopefully promote collaborative efforts from TTU researchers with those at other institutions.



# SUPPORTING MATERIALS



Graduate Students, Quy Ton Le (MS) and Chikezie Emeghara (Ph.D.), working in Smart Grid Lab, Summer 2020.



Solar panels on solar trailer at Shipley Farm.



Graduate Student, Charles Robinson (MS) working inside the solar trailer, Summer 2020.

## CESR FACULTY & STAFF—2019-2020

<b>Center Director:</b>	Satish M. Mahajan, Professor	Director, CESR
<b>Center Faculty:</b>	Charles Van Neste	Assistant Research Professor
<b>Center Staff:</b>	Robert Craven	R & D Engineer
	Barbara Fenlon	Administrative Associate 4
	Tammy Martin (Part Time)	Administrative Associate 3
	Anysa Milum (also with CMR)	Financial Associate 6
	Etter Staggs	Financial Analyst
<b>CESR Staff (Part Time, Temporary):</b>		
	Samuel Hollifield	Research Assistant
	Isaac Reff	Research Assistant
	George Rucker	Research Assistant
	Nicholas Skjellum	Research Assistant



Faculty participating in the Strategic Research of the Center are:

### **Smart Grid**

Mohammad Alam—CSC  
Ali Alouani – ECE  
Rabie Belkacemi – ECE  
Indranil Bhattacharya – ECE  
Robert Craven – CESR  
Sheikh Ghafoor – CSC  
Maanak Gupta—CSC  
Syed Rafay Hasan – ECE  
Muhammad Ismail—CSC  
Brian Leckie—Agriculture  
Satish Mahajan – ECE  
Mohamed Mahmoud – ECE  
Joseph Ojo – ECE  
Ghadir Radman – ECE  
Michael Rogers—CSC  
Susmit Shannigrahi—CSC  
Ambareen Siraj – CSC  
Denis Ulybyshev—CSC  
Charles Van Neste – CESR  
Ahmad Vasselbehagh—ME

### **Resilient Infrastructure**

Steven Anton—ME  
Daniel Badoe – CEE  
Joseph Biernacki – CHE  
J.W. Bruce—ECE  
Laura Arias Chavez – CHE  
Steven Click – CEE  
L. K. Crouch – CEE  
Jie Cui—ME  
Jerry Gannod – CSC  
Craig Henderson – CEE  
Timothy Huff – CEE  
Sharon Huo – CEE  
Stephen Idem – ME  
Alfred Kalyanapu—CEE  
Ethan Languri – ME  
Jane Liu – CEE  
Allen MacKenzie—ECE  
Benjamin Mohr – CEE  
Vahid Motevalli—Engineering  
Jessica Oswald—Engineering  
Venkat Padmanabhan – CHE  
Mustafa Rajabali - PHY  
Daniel VandenBerge – CEE  
Charles Van Neste—CESR  
Liqun Zhang – CHE

**CONTRACT AND GRANT AWARDS**

**Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
531309	Tennessee Louis Stokes Alliance for Minority Participation, Year 1 (TLSAMP), (Principal Investigator Jessica Oswalt)	Tennessee State University (TSU), Funding from the National Science Foundation (NSF)	9/1/18-8/31/19	26,100.00	18,375.00
531298	EAGER SitS: A Multi-Sensor Probe Network for Continuous Monitoring of the Soil Health, Year 2 (Principal Investigator Charles Van Neste, Co-Principal Investigator Satish M. Mahajan and Co-Principal Investigator Brian Leckie)	National Science Foundation	10/1/19-9/30/21	74,012.00	68,454.33
531294	CyberTraining: CDL: iPDC - Summer Institute for Integrating Parallel and Distributed Computing in Introductory Programming Classes, Year 3 (Principal Investigator Sheikh Ghafoor, Co-Principal Investigator Mike Rogers)	National Science Foundation	9/1/19-8/31/21	179,396.00	77,412.90
539371	Detection and Analysis of Malware in Critical Infrastructure (Principal Investigator Sheikh Ghafoor; Co-Principal Investigator Mike Rogers)	Oak Ridge National Laboratory	10/1/18-9/30/19	16,285.00	34,538.32
<b>SUB - TOTAL, GRANTS AND CONTRACTS</b>				<b>295,793.00</b>	<b>198,780.55</b>



**CONTRACT AND GRANT AWARDS  
Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
535262	Demonstrate Enhancement of Heat Transfer in Important Components of Grid Operations (Principal Investigator Ethan Languari)	External University Sponsor	6/27/19-12/31/20	196,544.00	171,461.60
535249	Application of Artificial Intelligence for Air Pollution Monitoring and Remediation using Neural Networks and Deep Learning (Principal Investigator Ahmad Vasselbehagh)	External University Sponsor	7/2/19-7/31/19	5,000.00	5,000.00
532388	Tracking Water Storage in Lakes: Citizens and Satellites Implementation Phase - Year 2 (Principal Investigator Sheikh Ghafoor)	The University of North Carolina at Chapel Hill (Funding from NASA)	6/25/19-6/24/20	83,495.00	64,215.62
531311	Collaborative Research: CyberTraining: Pilot: Semi-Automatic Assessment of Parallel Programs in Training of Students and Faculty (Principal Investigator Sheikh Ghafoor)	National Science Foundation	9/1/19-8/31/20	39,881.00	30,104.33
535260	Hybrid AC/DC Islanded Micro-Grids in Qatar: Planning, Operation, and Cyber Security (Principal Investigator Mohamed Mahmoud)	External University Sponsor	8/1/16-8/1/19	10,800.00	24,040.65
<b>SUB - TOTAL, GRANTS AND CONTRACTS</b>				<b>335,720.00</b>	<b>294,822.20</b>

**CONTRACT AND GRANT AWARDS  
Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
535248	Consolidation and Unit Weight Testing of Aeroaggregate (Principal Investigator Daniel VandenBerge)	External University Sponsor	7/12/19-1/11/20	6,000.00	5,304.19
531313	Collaborative Research: Software Engineering Workforce Development in High Performance Computing for Digital Twins (Principal Investigator Gerald Gannod, Co-Principal Investigator Sheikh Ghafoor)	National Science Foundation	10/1/19-9/30/21	42,365.00	2,952.94
532602	Simulation of HF Inverter Circuits for High-Power Wireless Charging (Principal Investigator Satish M. Mahajan)	Oak Ridge National Laboratory	10/10/19-1/17/20	12,234.00	12,234.00
539237	SimBRS II TO008- Adaptive and Reconfigurable Sensor Elements and Networks for Monitoring Critical Infrastructure and Maneuver Corridors (Principal Investigator Charles Van Neste, Co-Principal Investigator Satish M. Mahajan)	External University Sponsor	9/25/19-9/24/20	957,444.48	531,929.46
539377	From Can't to Can: Attack Prevention and In-Situ Detection of Advanced Attacks or Controller Area Networks (Principal Investigator Sheikh Ghafoor)	Oak Ridge National Laboratory	10/1/19-9/30/20	17,000.00	26,747.97
<b>SUB - TOTAL, GRANTS AND CONTRACTS</b>				<b>1,035,043.48</b>	<b>579,168.56</b>

**CONTRACT AND GRANT AWARDS**  
**Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
539027	Advanced Wake Loss Modeling for Large Wind Farms with Variable Wind Speed and Direction (Principal Investigator Ahmad Vasselbehagh)	External University Sponsor	10/1/19-2/16/21	20,715.00	9,571.83
533235	Implementing a Preference-Based, Person-Centered Communication Tool in Tennessee (Principal Investigator Gerald C. Gannod)	Miami University (Funding from the Tennessee Department of Health)	11/1/19-10/31/20	49,449.00	25,974.81
539385	Investigating Early Transition Metal Dopant Effects in Cobalt Free Lithium ion Batteries (Principal Investigator Indranil Bhattacharya)	Oak Ridge National Laboratory	10/1/19-12/31/20	54,255.00	31,537.40
539507	MRI: Development of a High Resolution Neutron Detector for Decay and Reaction Studies with Exotic Nuclei (Principal Investigator Mustafa Rajabali)	National Science Foundation via the University of Tennessee at Knoxville	8/15/19-7/31/20	48,509.00	6,765.21
531309	Tennessee Louis Stokes Alliance for Minority Participation, Year 2 (TLSAMP), (Principal Investigator Jessica Oswalt)	Tennessee State University (TSU), Funding from the National Science Foundation (NSF)	9/1/19-8/31/20	26,100.00	10,500.00
<b>SUBTOTAL, GRANTS AND CONTRACTS</b>				<b>199,028.00</b>	<b>84,349.25</b>

**CONTRACT AND GRANT AWARDS**  
**Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
532602	Simulation of HF Inverter Circuits for High-Power Wireless Charging (Principal Investigator Satish M. Mahajan)	Oak Ridge National Laboratory	1/18/20-5/31/20	15,021.00	15,021.00
535249	Developing a Signal Processing Toolbox for Air Pollution Monitoring and Remediation Applications (Supplement) (Principal Investigator Ahmad Vasselbehagh)	External University Sponsor	9/27/19-11/29/19	4,494.00	4,494.00
535259	Efficient Energy Management System with Integrated Cybersecurity Measures in Qatar's Smart Grid - Year 2 Supplement (Principal Investigator Mohamed Mahmoud; Co-Principal Investigator Muhammad Ismail)	External University Sponsor	4/1/19-3/31/20	17,163.60	70,065.73
532602	Simulation of HF Inverter Circuits for High-Power Wireless Charging - Travel Supplement (Principal Investigator Satish M. Mahajan)	Oak Ridge National Laboratory (ORNL)	1/18/20-5/31/20	3,000.00	-
<b>SUB - TOTAL, GRANTS AND CONTRACTS</b>				<b>39,678.60</b>	<b>89,580.73</b>



**CONTRACT AND GRANT AWARDS**  
**Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
531200	REU Site: Immersive Research in Energy Generation, Storage/ Conversion, and Power Transmission (Principal Investigator Indranil Bhattacharya, Co-Principal Investigator Joe Biernacki, Senior Personnel J. Wayne Bruce, Pigen Chen, Cynthia Rice, Steven Anton, Holly Stretz, Jane Liu, George Chitiyo)	National Science Foundation	3/1/20-2/28/21	107,421.00	54,623.75
539377	From Can't to Can: Attack Prevention and In-Situ Detection of Advanced Attacks or Controller Area Networks (Principal Investigator Sheikh Ghafoor)	Oak Ridge National Laboratory	10/1/19-9/30/20	17,805.00	15,440.55
532604	Research of Machine-Learning Based Cybersecurity Tools (Principal Investigator Sheikh Ghafoor)	Oak Ridge National Laboratory	4/15/20-12/31/20	19,704.08	3,016.07
532279	The Structure of Neutron-Rich Deformed Nuclei Studied by Beta Decay (Principal Investigator Mustafa Rajabali)	Department of Energy	5/1/20-4/30/21	78,000.00	115,733.08
532392	Summer 2020 High School STEM Teacher Workshop (Principal Investigator Vahid Motevali, Co-Principal Investigator Darek Potter)	University of Florida Transportation Institute (UFTI), Department of Transportation	1/31/20-12/31/20	12,000.00	21,679.68
<b>SUBTOTAL, GRANTS AND CONTRACTS</b>				<b>234,930.08</b>	<b>210,493.13</b>

**CONTRACT AND GRANT AWARDS**  
**Activated Between July 1, 2019 and June 30, 2020**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
535272	Enabling Efficient Integration of Electric Vehicles in Qatar's Smart Grid: Planning, Operation and Cybersecurity - Year 1 (Principal Investigator Mohamed Mahmoud)	External University Sponsor	1/1/20-1/1/21	30,264.00	-
535271	Enabling Efficient Integration of Electric Vehicles in Qatar's Smart Grid: Planning, Operation an Cybersecurity - Year 1 (Principal Investigator Muhammad Ismail)	External University Sponsor	1/1/20-1/1/21	35,005.20	1,503.36
535259	Efficient Energy Management System with Integrated Cybersecurity Measures in Qatar's Smart Grid - Year 3 Supplement (Principal Investigator Mohamed Mahmoud; Co-Principal Investigator Muhammad Ismail)	External University Sponsor	4/1/20-3/31/21	47,151.60	3,569.40
535274	Novel Endogenous Beta Defensin based Therapeutics to Treat COVID-19 Patients (Principal Investigator Liqun Zhang)	External University Sponsor	4/24/20-10/31/20	8,000.00	342.30
<b>SUBTOTAL, GRANTS AND CONTRACTS</b>				<b>120,420.80</b>	<b>5,415.06</b>

**CONTRACT AND GRANT AWARDS  
Activated Between July 1, 2019 and June 30, 2020**

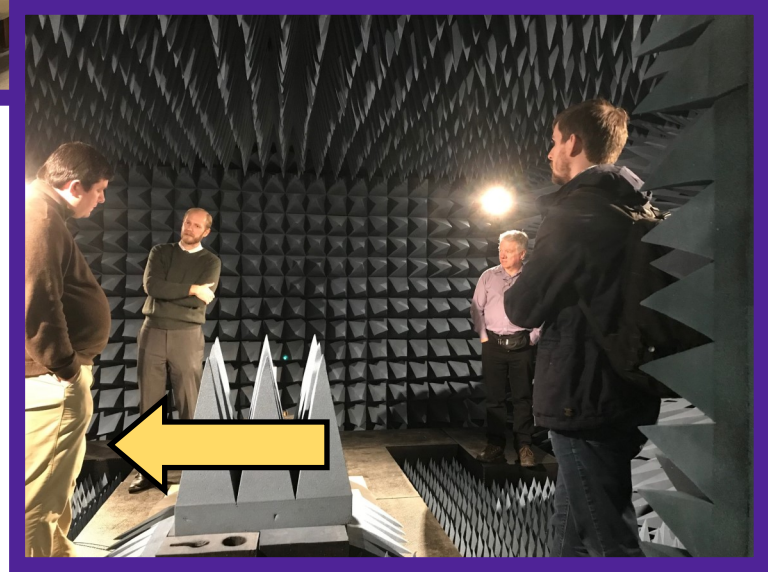
<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
532803	Academic Review and Rewrite of NAVFAC-DM 7.02 (Principal Investigator Daniel Vandenberg)	External University Sponsor	5/21/20-9/30/20	29,700.00	-
532602	Simulation of HF Inverter Circuits for High-Power Wireless Charging (Principal Investigator Satish M. Mahajan)	Oak Ridge National Laboratory	6/1/20-12/31/20	19,218.00	2,436.39
535249	Supplement - Application of Artificial Intelligence Air Pollution Monitoring and Remediation using Neural Network and Deep Learning (Principal Investigator Ahmad Vasselbehagh)	External University Sponsor	5/15/20-5/30/20	1,125.00	79.44
531279	Supplement to Tennessee Cybercorps: A Hybrid Program in Cybersecurity - Community College Inclusion 2018-2021, Year 2 (Principal Investigator Ambareen Siraj; Co-Principal Investigator Doug Talbert)	National Science Foundation	8/1/19-7/31/20	14,172.00	14,172.00
531279	Supplement to Tennessee Cybercorps: A Hybrid Program in Cybersecurity - Community College Inclusion 2018-2021, Year 3 (Principal Investigator Ambareen Siraj; Co-Principal Investigator Doug Talbert)	National Science Foundation	8/1/19-7/31/20	18,432.00	18,432.00
<b>SUBTOTAL, GRANTS AND CONTRACTS</b>				<b>82,647.00</b>	<b>35,119.83</b>

**CONTRACT AND GRANT AWARDS  
Activated Between July 1, 2019 and June 30, 2020**

**POWER-TEST-SERVICE ACCOUNT**

<b>Contract Number</b>	<b>Title</b>	<b>Source</b>	<b>Project Dates</b>	<b>Total Amount</b>	<b>Estimated Expendit.</b>
538597	Power-Test-Service Account (Principal Investigators: Professor and Director Satish M. Mahajan; Professor Stephen Idem, and Professor L. K. Crouch)	Various	7/1/19-6/30/20	13,017.00	16,559.52
<b>SUB-TOTAL</b>				<b>13,017.00</b>	<b>16,559.52</b>
<b>POWER-TEST-SERVICE ACCOUNT</b>					
<b>TOTAL CONTRACTS AND GRANTS DURING 2019-2020</b>				<b>2,356,277.96</b>	<b>1,514,288.83</b>





Mr. Josh Fairley, Research Electrical Engineer, ERDC, visiting Tennessee Tech's Laboratory for Wireless Power Transmission.



Mr. Josh Fairley, Research Electrical Engineer, ERDC, visiting Tennessee Tech's Wireless Earth Transmission site.



CESR Advisory Board Members visiting Tennessee Tech's Battery Research Laboratory. (March 2020)

**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
1.	Consolidation and Unit Weight Testing of Aeroaggregate	Daniel VandenBerge	External University Sponsor	6,000.00	Funded
2.	CAREER: The Role of Physiochemical Properties of Polymer on its Gas Separation Performance	Venkat Padmanabhan	National Science Foundation	573,424.00	Pending
3.	CAREER: Innovations in Characterization and Engineering of Stiff Natural and Compacted Clays using a Stiffness--Based Approach	Daniel VandenBerge	National Science Foundation	505,658.00	Unfunded
4.	Collaborative Research: Understanding and Modeling of Thermal Transport Processes within Near-Ground Atmosphere in the Presence of Utility-Scale Solar Photovoltaics (PV) Plants	Ahmad Vasselbehagh	National Science Foundation	368,055.00	Pending
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>1,453,137.00</b>	



**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
5.	Simulation of HF Inverter Circuits for High-Power Wireless Charging	Satish M. Mahajan	Oak Ridge National Laboratory	12,234.00	Funded
6.	SCC-PG: Enhancing and Preserving the Quality of Life for Citizens with Assistance Needs in Depopulating Communities	Charles Van Neste	Subaward to Johns Hopkins University, National Science Foundation	35,000.00	Unfunded
7.	Academic Review and Rewrite of NAVFAC-DM 7.02	Daniel VandenBerge	External University Sponsor	353,223.00	Initial Funding at \$29,700
8.	Investigating Early Transition Metal Dopant Effects in Cobalt Free Lithium ion Batteries	Indranil Bhattacharya	Oak Ridge National Laboratory	54,255.00	Funded
9.	A Secure Energy Management System for Smart Grids using Deep Learning	Mohamed Mahmoud and Muhammad Ismail	National Academy of Sciences	200,000.00	Pending
10.	UFC 3-220-10N Soil Mechanics (DM7-01) - Supplement 2	Daniel VandenBerge	Virginia Tech via U.S. Navy	12,000.00	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>666,712.00</b>	



**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
11.	Collaborative Research: SHF: Medium: Transformative Message Passing Research for Performance, Portability, and Predictability	Sheikh Ghafoor with Collaborators Anthony Skjellum, University of Tennessee at Chattanooga \$428,412; Purushotham Bangalore, University of Alabama at Birmingham \$372,649	National Science Foundation	373,939.00	Unfunded
12.	Collaborative Research: MLWiNS: ICON-Intelligent Cooperative Optimal Networking for Mobile Indoor 5G+ Heterogeneous Wireless Network	Muhammad Ismail (Collaborator Erchin Serpedin, Texas A&M University)	National Science Foundation/Intel	683,491.00	Unfunded
13.	Advanced Metal Anodes for Lithium Metal Secondary Batteries	Liqun Zhang	Subaward from LiBAMA, LLC (Department of Defense; Tennessee Government Matching Fund)	21,500.00	Unfunded
14.	Heat Pump Refrigerant to Water Heat Transfer Optimization - Phase 1 and Phase 2	Ethan Languri and Stephen Idem	External University Sponsor	89,122.00	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>1,168,052.00</b>	

**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
15.	Collaborative Research: SHF: OAC Core: Small: Dynamics, Elastic, and Resource-Conscious MPI for Exascale and Clouds	Sheikh Ghafoor	National Science Foundation	166,395.00	Unfunded
16.	Efficient Energy Management System with Integrated Cybersecurity Measures in Qatar's Smart Grid	Mohamed Mahmoud and Muhammad Ismail (Total project funded at \$124,291.20)	External University Sponsor	34,327.20	Funded
17.	The Structure of Neutron-rich Nuclei Studied via Beta Decay	Mustafa Rajabali	Department of Energy	448,880.00	Funded at \$251,000
18.	Developing a Signal Processing Toolbox for Air Pollution Monitoring and Remediation Applications	Ahmad Vaselbehagh	Industrial Sponsor	4,494.00	Funded
19.	Going Beyond ACI 332: Commercial/ Residential Enhanced Durability: Phase II What If?	L. K. Crouch	Tennessee Concrete Association	5,562.00	Funded
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>659,658.20</b>	

**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
20.	Collaborative Research: Sheikh Ghafoor CyberTraining: Implementation: Medium: Broadening Adoption of Parallel and Distributed Computing in Undergraduate Computer Science and Engineering Curricula		National Science Foundation via the University of Texas at San Antonio (UTSA)	64,220.00	Funded
21.	CC*CRIA: Planning a Regional Research Network Infrastructure for Central Tennessee, Track 6	Sheikh Ghafoor	National Science Foundation via the University of Tennessee at Chattanooga (UTC)	82,964.00	To be funded
22.	Investigation on Wax Inhibition of Pour Point Depressant Using Molecular Dynamics Simulation Method	Liqun Zhang	American Chemical Society	110,000.00	Pending
23.	A Spreadsheet-based Teaching Aid for Advanced Steel Design	Timothy Huff	American Institute of Steel Construction	10,000.00	Pending
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>267,184.00</b>	

**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
24.	SmartWake: A Data-Driven, Uncertainty-Inclusive Software for Wake Steering via Yaw Control	Ahmad Vasselbehagh	NYSERDA, National Offshore Wind Research and Development Consortium via University of Delaware	138,772.00	Unfunded
25.	Simulation of HF Inverter Circuits for High-Power Wireless Charging - Supplement	Satish M. Mahajan	Oak Ridge National Laboratory	15,021.00	Funded
26.	Collaborative Research: Fundamental Study on the Non-Equilibrium Water Foaming Process with Advanced Molecular Simulations and Interfacial Characterization	Liqun Zhang (Collaborative with Dr. Yu from Case Western Reserve University \$242,799)	National Science Foundation	241,998.00	Pending
27.	NRT-FW-HTF: Engendering the Spirit of Gadugi at the Food-Energy-Water Nexus	Pedro Arce and Laura Arias Chavez, Tania Datta, Ada Haynes, and Robby Sanders	National Science Foundation	3,000,000.00	Pending
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>3,395,791.00</b>	

**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
28. Quasi-Wireless Capacitive (QWiC) Surface Power for Adaptive and Reconfigurable Sensor Elements on Space Infrastructure	Charles Van Neste, Satish M. Mahajan, Denis Ulybyshev, Maanak Gupta	National Aeronautics and Space Administration (NASA)	60,405.00	Funded
29. Privacy-Preserving Health Monitoring System Using AI and Non-Intrusive Smart Sensors	Mohamed Mahmoud and Mostafa Fouda	Qatar National Research Fund	140,000.00	Pending
30. Machine Learning-Based Design and Operation of Next Generation Software-Defined Heterogeneous Networks	Muhammad Ismail	External University Sponsor	173,999.00	Pending
31. Secure Federated Edge Intelligence Framework for AI-driven 6G Applications	Mohamed Mahmoud and Mostafa Fouda	External University Sponsor	85,998.00	Pending
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>			<b>460,402.00</b>	



**CENTER FOR ENERGY SYSTEMS RESEARCH**

**STATUS OF PROPOSALS**

**Submitted Between July 1, 2019 through June 30, 2020**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
32.	Enabling Efficient Integration of Electric Vehicles in Qatar's Smart Grid: Planning, Operation, and Cybersecurity	Muhammad Ismail	External University Sponsor	104,872.80	Year 1 funded; Years 2 and 3 to be Funded
33.	Collaborative Research: Understanding the Antibacterial Mechanisms of Human Beta Defensin-Structure and Dynamics Investigation	Liqun Zhang	National Science Foundation with Louisiana State University	317,761.00	Unfunded
34.	Research of Machine-Learning Based Cybersecurity Tools	Sheikh Ghafoor	Oak Ridge National Laboratory	19,704.00	Funded at \$19,704.08
35.	Novel Endogenous Beta Defensin Based Therapeutics to Treat COVID-19 Patients	Liqun Zhang	Case Medical School (Case Western Reserve University)	30,000.00	Unfunded
36.	Novel Endogenous Beta Defensin Based Therapeutics to Treat COVID-19 Patients	Liqun Zhang	Case Medical School (Case Western Reserve University)	8,000.00	Funded
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>480,337.80</b>	

## CENTER FOR ENERGY SYSTEMS RESEARCH

## STATUS OF PROPOSALS

Submitted Between July 1, 2019 through June 30, 2020

TITLE	INVESTIGATORS	SOURCE	AMOUNT	STATUS
37. Collaborative Research: SitS: Wirelessly Powered Multi-Sensor Probe Network for Continuous Monitoring of Soil Health	Charles Van Neste, Brian Leckie, Satish M. Mahajan	National Science Foundation with SUNY at Buffalo, and the University of Tennessee, Knoxville (UTK)	400,000.00	Pending
38. Resiliency Tester "Bouncer" for Superior Graphite	Jie Cui, Stephen Idem	Superior Graphite	29,276.00	Funded
39. Developing a New Experiment-Based Renewable Energy Course	Ahmad Vasselbehagh	VentureWell Sustainable Design Faculty Grant	29,369.00	Pending
40. Investigation on Wax Inhibition using Polymer Pour Point Depressants	Liqun Zhang	American Chemical Society	110,000.00	Unfunded
41. Stabilizing Asphaltenes and Improving Flow Assurance of Crude Oil using Poly (Ionic Liquid) Grafted Nanoparticles	Venkat Padmanabhan	American Chemical Society	110,000.00	Pending
42. Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP)	Jessica Oswalt	Tennessee State University (TSU) from the National Science Foundation (NSF)	26,100.00	Funded
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>			<b>704,745.00</b>	

## CENTER FOR ENERGY SYSTEMS RESEARCH

## STATUS OF PROPOSALS

Submitted Between July 1, 2019 through June 30, 2020

TITLE	INVESTIGATORS	SOURCE	AMOUNT	STATUS
43. Collaborative Research: Innovative Strategy to Incorporate Waste Plastics into Asphalt	Liqun Zhang	Case Western Reserve University (Funding from Federal Highway Administration FHWA)	210,000.00	Pending
44. Standardized Test Method and Calculation Protocol for Determining and Reporting Annual Heat Rate for Coal-Fueled EGUs	Stephen Idem	McHale and Associates, Inc.	114,552.00	Pending
45. Regional Transportation Center on Reducing Congestion Year 5-6	Steven Click, Darek Potter	University of Florida Transportation Institute (UFTI); Department of Transportation	82,690.00	Pending
46. Novel Endogenous Beta Defensin Based Therapeutics to Treat COVID-19 Patients	Liqun Zhang	Case Western Reserve University via NORD Grant	3,000.00	Unfunded
47. Simulation of HF Inverter Circuits for High-Power Wireless Charging	Satish M. Mahajan	Oak Ridge National Laboratory	19,218.00	Funded
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>			<b>429,460.00</b>	

CENTER FOR ENERGY SYSTEMS RESEARCH

STATUS OF PROPOSALS

Submitted Between July 1, 2019 through June 30, 2020

	TITLE	INVESTIGATORS	SOURCE	AMOUNT	STATUS
48.	Artificial Intelligence based Material Datamining, Investigation of Optical and Electrical Characteristics and Current Matching in Novel Ultra-High-Efficiency Perovskite Multijunction Solar Cells	Indranil Bhattacharya	Department of Energy	273,739.00	Pending
49.	Human Beta Defensin 3 (hBD3) Interactions with Lipid Membranes and Chemokine Receptors	Liqun Zhang	National Institutes of Health	414,976.00	Pending
50.	Solar Powered Fast-Charging Stations for Mass Adoption of Electric Vehicles and Artificial Intelligence based Optimization of Cost-Function	Indranil Bhattacharya	Department of Energy	270,900.00	Pending
51.	CPS: Medium: Secure, Efficient and Fast Dynamic Wireless Power Transfer for Electric Vehicles	Indranil Bhattacharya, Susmit Shannagrahi, Maanak Gupta, Denis Ulybyshev	National Science Foundation	986,475.00	Pending
<b>SUBTOTAL, PROPOSALS FOR 2019-2020</b>				<b>1,946,090.00</b>	
<b>TOTAL, PROPOSALS FOR 2019-2020</b>				<b>11,631,569.00</b>	

## CESR Publications for 2019-2020 Fiscal Year

### Conference Papers:

- ◆ Chukwu, U.C.; **Mahajan, Satish M.**, “*The Prospects of V2G for Reactive Power Compensation in Electric Distribution Networks.*” Annual Meeting of the Power and Energy Systems General Meeting (PES GM); Atlanta, GA; August 2019.
- ◆ Kavimandan, Utkarsh D.; Galigekere, Veda P.; Onar, Omer; Ozpineci, Burak; and **Mahajan, Satish M.**, “*A Control Scheme to Mitigate the Dead-Time Effects in a Wireless Power Transfer System.*” IEEE Applied Power Electronics Conference and Exposition (APEC); March 2020.
- ◆ Kavimandan, Utkarsh D.; Galigekere, Veda P.; Onar, Omer; Ozpineci, Burak; and **Mahajan, Satish M.**; “*Comparison of Dead-Time Effects in a WPT System Inverter for Different Fixed-Frequency Modulation Techniques.*” IEEE Transportation Electrification Conference and Expo; ITEC-2020; June 2020.

### Peer Reviewed Journal Papers:

- ◆ Kavimandan, Utkarsh D.; **Mahajan, Satish M.**; Van Neste, Charles; “*Analysis and Demonstration of a Dynamic ZVS Angle Control Using a Tuning Capacitor in a Wireless Power Transfer System;*” IEEE Journal of Emerging and Selected Topics in Power Electronics PP (99):1-1 May 2020.
- ◆ Van Neste, Charles W.; Thundat, Thomas; Khosla, Ajit; Szanton, Sarah; and Nagahara, Larry A.; “*Perspective—Maintaining the Quality of Life in Depopulating Communities: Expanding Smart Sensing via a Novel Power Supply,*” J. Electrochem. Soc. Vol. 167, No. 3, (2020)
- ◆ Zou, Lixiang (Jackie); Zhu, Qi, **Van Neste, Charles W.**; and Hu, Aiguo (Patrick); “*Modelling Single-Wire Capacitive Power Transfer System with Strong Coupling to Ground,*” IEEE Journal of Emerging and Selected Topics in Power Electronics, (2019). Doi: 10.1109/JESTPE.2019.2942034
- ◆ Sohrabi, Amirreza; Haghghat, Ghazaleh; Shaibani, Parmiss Mojir; **Van Neste, Charles W.**; Naicker, Selvaraj; Sadrzadeh, Mohtada; Thundat, Thomas; “*Degradation of Pharmaceutical Contaminants in Water by an Advanced Plasma Treatment.*” Desalination and Water Treatment, Vol. 139, 202-221, (2019).



None for 2019-2020

September 3, 2019

**“Coordination and Control of Distributed Energy Resources: Modeling and Analysis Techniques”**

Md Salman Nazir

*Speaker Bio:*

Md Salman Nazir is currently a PhD candidate in the department of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor, where he works at the Michigan Power and Energy Laboratory (MPEL). Previously, he obtained his B.Eng. (Honours) and M.Eng. (Thesis) degrees, both in Electrical Engineering, from McGill University, Montreal, QC in 2011 and 2015, respectively. During 2012-2014, he was an engineer at the CanmetENERGY Laboratory of Natural Resources Canada. During summer of 2017, he was a graduate intern at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. Mr. Nazir’s research interests are in design and analysis of algorithms that facilitate integration of renewable and distributed energy resources in the power grid, for which he applies various techniques from control, optimization, statistics and game theory.

October 8, 2019

**“Designing Enduring Infrastructure for EV Charging”**

Matthew Pearce

*Speaker Bio:*

Matthew Pearce received his B.E. degree (Hons.) from The University of Auckland, New Zealand, in 2014. He then worked at Fisher & Paykel Healthcare designing electronics for respiratory medical devices for a year before returning to the University of Auckland in January 2016 to begin his PhD in Inductive Power Transfer for roadway electric vehicle charging, where he is currently writing his thesis. His current research interests include the design of power electronics and couplers for wireless electric vehicle charging.



Aneesh Davalbhakta, PE

March 5, 2020

## “Introduction to Arc Flash”

*Speaker Bio:*

Mr. Davalbhakta is a Senior Electrical Engineer with Mesa Associates, Inc., Knoxville, Tennessee. He has Bachelors and Masters degrees in electrical engineering. He has 11 years of design experience in the field of power generation.

March 13, 2020

## “The Complexities of Wind Flow Through Wind Power Plants”

*Speaker Bio:* Matt Churchfield is a senior researcher at the National Renewable Energy Laboratory (NREL) in Colorado. He is part of NREL’s National Wind Technology Center. His research focuses on wind plant aerodynamics. He is particularly interested in wind-turbine wake effects, mesoscale-microscale weather coupling, the effects of atmospheric stability on wind-plant behavior, turbulence modeling, and wind-plant control. Matt earned his B.S. in Mechanical Engineering from the University of Nevada, Reno and his M.S. and Ph.D. from Purdue University’s School of Aeronautics and Astronautics before joining NREL as a postdoc in 2009 and staff researcher in 2011.



Dr. Matthew Churchfield

**GRADUATE THESIS/DISSERTATIONS AND OTHER STUDENT PUBLICATIONS**  
**MASTERS**

**ARMSTRONG ABOAH**

An Investigation into the Factors that Influence the Use of Transportation Network Company Services using National Household Travel Survey Data

Fall 2019

Professor Daniel Badoe

Civil Engineering

**WESAM ABDELRAHMAN MOHAMMAD AL AMIRI**

A Blockchain-Based Smart Parking System with Privacy-Preservation and Reputation Management

Spring 2020

Associate Professor Mohamed Mahmoud

Electrical and Computer Engineering

**SUDIPTO CHAKRABORTY**

Geopolymerization of Simulated Martian Soil

Summer 2019

Chair and Associate Professor Benjamin Mohr

Civil Engineering

**ANIMESH DAHAL**

Director and Professor Ambareen Siraj

Summer 2019

Computer Science

**NICHOLAS ANDREW DAVIS**

Earthquake Ground Motion Suites for Nuclear Safety-Related Structures in Oak Ridge, TN

Spring 2020

Assistant Professor Timothy Huff

Civil Engineering

**MADISON ELIZABETH DITTNER**

Development of a Geometry Optimization Platform Using an In-House Developed Genetic Algorithm: Case of a Bladeless Wind Turbine

Spring 2020

Assistant Professor Ahmad Vasselbehagh

Mechanical Engineering

**KATIE M. GROVES**

A Complete Methodology for Implementing Deep Learning Architecture on PYNQ-Z1: Leveraging Pipeline and Distributed Network

Fall 2019

Associate Professor Syed Rafay Hasan  
Electrical and Computer Engineering

**A H M JAKARIA**

Formal Techniques for Automated Design of Adaptive Networked Systems Based on Security and Resiliency Requirements

Fall 2019

Director and Professor Ambareen Siraj  
Computer Science

**LYDIA KATHLEEN JOHNSON**

Modeling Trip Generation with Metropolitan and National Household Travel Survey Data

Fall 2019

Professor Daniel Badoe  
Civil Engineering

**PRAJJWAL RAJ KANDEL**

Node Similarity for Anomaly Detection in Attributed Graphs

Fall 2019

Professor William Eberle  
Computer Science

**NATHAN A. MARTINDALE**

Detecting Bias in News Article Content with Machine Learning

Spring 2020

Associate Chair Douglas Talbert  
Computer Science

**SAMUEL AUSTIN MATHEWS**

Going Beyond ACI 332: Commercial/Residential Enhanced Durability Concrete

Spring 2020

Professor L. K. Crouch  
Civil Engineering



**RYAN ROSS NASH**

Wind Farm Wake Control  
Spring 2020  
Assistant Professor Ahmad Vasselbehagh  
Mechanical Engineering

**BABAJIDE Y. ONANUGA**

Time Dependent Rheological Behavior of Particulate Suspensions  
Spring 2020  
Professor Joseph Biernacki  
Chemical Engineering

**RANI PENUMAKA**

Spring 2020  
Professor Mohan Rao  
Mechanical Engineering

**MICAH DAVID RENTSCHLER**

Optimal Junction Parameters to Improve the Quantum Efficiency of Multi-Junction Perovskite/III-V Solar Cells  
Fall 2019  
Associate Professor Indranil Bhattacharya  
Electrical and Computer Engineering

**KOLAWOLE ALADE SONIBARE**

Molecular Dynamics Simulation Study on Biomass-Modified Asphalt  
Spring 2020  
Assistant Professor Liqun Zhang  
Chemical Engineering

Number of MS Students: 17

**GRADUATE THESIS/DISSERTATIONS AND OTHER STUDENT PUBLICATIONS****PHD****ISMAEL KHORSHEH ABDULRAHMAN**

Wide-Area Based Power System Modeling, Optimization, Control and Visualization Considering Optimal PMU Placement and Adaptive Time-Delay Compensation

Fall 2019

Professor Ghadir Radman

Engineering

**MULUKEN T. HAILESELLASIE**

Hardware Architecture Design for Regular Convolutional Neural Networks Targeting Resource-constrained Devices with an Automated Framework

Summer 2019

Associate Professor Syed Rafay Hasan

Engineering

**A H M JAKARIA**

Formal Techniques for Automated Design of Adaptive Networked Systems Based on Security and Resiliency Requirements

Spring 2020

Director and Professor Ambareen Siraj

Engineering

**MAHMOUD N. MAHMOUD**

Electricity Theft Detection with Privacy Preservation for Smart Grid AMI Networks Using Machine Learning

Summer 2019

Associate Professor Mohamed Mahmoud

Engineering

**KOTESWARA RAO MEDIDHI**

Structural and Thermo-Mechanical Properties of Polymer Nanocomposites

Spring 2020

Assistant Professor Venkat Padmanabhan

Engineering

**MADHI MOHAMMADIZADEH**

Mechanical and Thermal Analyses of Automotive Components Manufactured with 3D Printed Continuous Fiber Reinforced Thermoplastic Polymers

Spring 2020

Professor Ismail Fidan

Engineering

**VENKATA AVINASH PARUCHURI**

Experimental and Finite Element Analysis of Typical Duct Systems

Fall 2019

Professor Stephen Idem and Professor Jane Liu

Engineering

Number of Ph.D. Students: 7

## MS STUDENTS

Name	Dept.	Source of Support	Anticipated Graduation Date	Advisor
Aboah, Armstrong	CEE	CEE/CESR	Fall 2019	Professor Daniel Badoe
Afolayan, Deborah	ECE	CESR	Fall 2022	Director/Professor Satish M. Mahajan
Al Amiri, Wesam	ECE	CESR/ECE	Spring 2020	Associate Professor Mohamed Mahmoud
Banik, Trapa	ECE	TVA/CESR	Spring 2021	Associate Professor Indranil Bhattacharya
Coultis, Michael	ECE	CESR/External University Sponsor	Fall 2020	Research Assistant Professor Charles Van Neste
Davis, Nicholas	CEE	CESR/CEE	Spring 2020	Assistant Professor Timothy Huff
Dean, Jonathan	ECE	CESR/External University Sponsor	Spring 2021	Research Assistant Professor Charles Van Neste
Dittner, Madison	ME	CESR/ Fellowship	Spring 2020	Assistant Professor Ahmad Vasselbehagh
Gibson, Jonathan	CSC	ORNL	Fall 2020	Professor Sheikh Ghafoor
Gollapudi, Anusha Sai	ECE	CESR/ECE	Fall 2021	Professor Ghadir Radman
Himes, Joseph Hunter	CHE	ORNL	Fall 2020	Assistant Professor Laura Arias Chavez
Huck, Caleb	CSC	CSC/External University Sponsor	Spring 2021	Professor Sheikh Ghafoor
Khant, Aung	CEE	CESR	Spring 2021	Professor Jane Liu
Kiss, Agoston	CHE	CESR/ Research Administration	Spring 2021	Professor Holly Stretz
Le, Quy Ton	ECE	CESR	Fall 2022	Professor Ghadir Radman; Director/ Professor Satish M. Mahajan
Lina, Debolina Halder	CSC	NASA	Summer 2021	Professor Sheikh Ghafoor
Martindale, Nathan	CSC	Advancement/ Miami University	Spring 2020	Chairperson Gerald Gannod

Name	Dept.	Source of Support	Anticipated Graduation Date	Advisor
Mathews, Sam	CEE	CESR/CEE	Spring 2020	Professor L. K. Crouch
Mingen, Tanner	ECE	TVA/CESR	Fall 2021	Research Assistant Professor Charles Van Neste
Nash, Ryan	ME	CESR	Spring 2020	Assistant Professor Ahmad Vasselbehagh
Penfield, Jackson	CHE	CESR/CHE	Fall 2020	Assistant Professor Liqun Zhang
Robinson, Charles	ECE	NSF	Fall 2020	Research Assistant Professor Charles Van Neste
Schaff, Cameron	CEE	CESR	Fall 2020	Professor Jane Liu
Worley, Andrew	CSC	NSF, ORNL, CESR	Spring 2021	Professor Sheikh Ghafoor

**PHD STUDENTS**

Abdelfattah, Sherif	ECE	NSF	Spring 2022	Associate Professor Mohamed Mahmoud
Abdelrahman, Walid	ECE	CESR/NSF	Left the University	Associate Professor Mohamed Mahmoud
Bain, Aaron	ME	External University Sponsor	Spring 2022	Assistant Professor Ethan Languri
Baza, Mohamed	ECE	CESR/External University Sponsor	Summer 2020	Associate Professor Mohamed Mahmoud
Bima, Muhammad E.	ECE	CESR/ECE	Spring 2021	Associate Professor Indranil Bhattacharya
Darbar, Devendrasinh	ECE	TVA/ORNL	Spring 2021	Associate Professor Indranil Bhattacharya
Dean, Jonathan	ECE	External University Sponsor	Spring 2021	Research Assistant Professor Charles Van Neste
Emeghara, Chikezie	ECE	CESR	Fall 2023	Director/Professor Satish M. Mahajan



## PHD STUDENTS (continued)

Name	Dept.	Source of Support	Anticipated Graduation Date	Advisor
Hines, Thomas	CSC	NSF	Spring 2022	Professor Sheikh Ghafoor
Jaladi, Divya	ME	CESR	Spring 2021	Assistant Professor Ethan Languri
Kavimandan, Utkarsh	ECE	ORNL/CESR	Fall 2020	Director/Professor Satish M. Mahajan
Kodali, Chaitanya	ME	ME/CESR	Spring 2021	Professor Stephen Idem
Li, Xuebin	ECE	CESR	Fall 2021	Chairperson/Professor Allen MacKenzie
Mohammad, Abdul Salam	CHE	CESR	Spring 2021	Professor Joseph Biernacki
Prabhu, Vinit	ME	CESR	Fall 2020	Assistant Professor Ethan Languri
Yeasmin, Rabeta	CHE	CESR	Fall 2021	Assistant Professor Liqun Zhang
Yilmaz, Ibrahim	CSC	CESR	Spring 2022	Professor/Director Ambareen Siraj

CEE Civil and Environmental Engineering (Tennessee Technological University)  
 CESR Center for Energy Systems Research (Tennessee Technological University)  
 CHE Chemical Engineering (Tennessee Technological University)  
 CSC Computer Science (Tennessee Technological University)  
 ECE Electrical and Computer Engineering (Tennessee Technological University)  
 ME Mechanical Engineering (Tennessee Technological University)  
 NASA National Aeronautics and Space Administration  
 NSF National Science Foundation  
 ORNL Oak Ridge National Laboratory  
 TDOT Tennessee Department of Transportation  
 TVA Tennessee Valley Authority

<u>Undergraduate Students</u>	<u>Degree and Major</u>
Maci Arms	B.S. CE
Dipayan Banik	B.S. CSC
Adam Becklehimer	B.S. CSC
Brian Bowman	B.S. CE
Ann Brewer	B.S. Biology
Levi Carroll	B.S. EE
Glen Cathey	B.S. CSC
Matthew Crispi	B.S. CE
Grant Crumpton	BFA Fine Arts
Viviana Cruz	B.S. CHE
Rachel Cullison	B.S. Physics
Andrew Davis	B.S. ME
Sean Denn	B.S. CompEngr
Samuel Dunham	B.S. CE
Adrianna Eastep	B.S. CHE
Pedro Garza-Ramos	B.S. ME
Nathan Ghattas	B.S. ECE
Samuel Hollifield	B.S. CompEngr
Robert Hughes	B.S. CE
Sean Jones	B.S. EE
Brandon Kemp	B.S. CSC
Aaron Kindred	B.S. Physics
Whitney Kirby	B.S. EE
Evan Kixmiller	B.S. ME
Sung Kyung Lee	B.S. ME
Benjamin Luna	B.S. Physics
Tyler Marcrum	B.S. EE
Austin Marler	B.S. ME
Richard Mitchell	B.S. CSC
Joshua Nichols	B.S. CSC
Brandon Nieman	B.S. EE
Alexander Palentyn	B.S. CE
Mackenzie Pugh	B.S. CHE
George Rucker	B.S. CHE
Cameron Schaff	B.S. CE
William Stump	B.S. CompEngr
Kaylalyn Truman-Jarrell	B.S. CE
Allison Vance	B.S. CE
Jeffrey B. Yeates	B.S. Physics
Jonathan Zigler	B.S. EE

<u>M.S. Graduate Students</u>	<u>Degree and Major</u>
Armstrong Aboah	M.S. CEE
Lina Abounassif	M.S. CE
Deborah Afolayan	M.S. ECE
Wesam Al Amiri	M.S. ECE
Aaron Bain	M.S. ME
Trapa Banik	M.S. ECE
Michael Coultis	M.S. EE
Matthew Crispi	M.S. CE
Nicholas Davis	M.S. CEE
Nathan Ghattas	M.S. ME
Jonathan Gibson	M.S. CSC
Anusha Sai Gollapudi	M.S. ECE
Katie Groves	M.S. ECE
Caleb Huck	M.S. CSC
Joseph Hunter Himes	M.S. CHE
Samuel Hines	M.S. MATH
Robert Tyler Hughes	M.S. CE
Lydia Johnson	M.S. CEE
Christopher Kaczmarek	M.S. CE
Prajjwal Kandel	M.S. CSC
Aung Khant	M.S. CE
Agoston Kiss	M.S. CHE
William Luke Lambert	M.S. CSC
Quy Ton Le	M.S. ECE
Debolina Halder Lina	M.S. CSC
Tyler Marcrum	M.S. ECE
Sam Mathews	M.S. CE
Tanner Mingen	M.S. ECE
Richard Morrow	M.S. CE
Ryan Nash	M.S. ME
Jacob Nelson	M.S. CompEngr
Brandon Nieman	M.S. ECE
Alexander Palentyn	M.S. CE
Jackson Penfield	M.S. CHE
Vanessa Perez	M.S. ECE
Daniel Rikli	M.S. CE
Charles Robinson	M.S. EE
Cameron Schaff	M.S. CE
Houston Shearin	M.S. CSC
Kolawole Sonibare	M.S. CHE
Andrew Worley	M.S. CSC

<u>Ph.D. Graduate Students</u>	<u>Degree and Major</u>
Sherif Abdelfattah	Ph.D. ECE
Mahmoud Abouyoussef	Ph.D. CSC
Webster Adepoju	Ph.D. ECE
Mohamed Baza	Ph.D. ECE
Muhammad Bima	Ph.D. ECE
Katherine Brown	Ph.D. ME
Devendrasinh Darbar	Ph.D. ECE
Chikezie Emeghara	Ph.D. ECE
Qing Feng	Ph.D. EE
Josiah Haruna	Ph.D. EE
Thomas M. Hines	Ph.D. CSC
Saanyol Igbax	Ph.D. ME
Md Aminul Islam	Ph.D. CSC
Md Shariful Islam	Ph.D. CEE
Divya Jaladi	Ph.D. ME
Utkarsh Kavimandan	Ph.D. EE
Mahmoud Nabil Mahmoud	Ph.D. ECE
Koteswara Rao Medidhi	Ph.D. CHE
M. Rayhan Ahmed Mithu	Ph.D. CSC
Abdul Salam Mohammad	Ph.D. CHE
Kuseso Onai	Ph.D. EE
Babajide Onanuga	Ph.D. CHE
Vinit Prabhu	Ph.D. ME
Srinivas Kumar Vaibhave Ravinutala	Ph.D. ECE
Ahmed Shafee	Ph.D. ECE
Hajar Taheri Afarani	Ph.D. CHE
Prince Turkson	Ph.D. CE
Rabeta Yeasmin	Ph.D. CHE
Ibrahim Yilmaz	Ph.D. CSC

<u>Work Study/Work Scholarship</u>	<u>Degree and Major</u>
Jacob Epley	B.S. CSC
Haley Smallwood	B.S. ME

Undergraduate Student	Sponsor	Program	Faculty Advisor
Maci Arms	Tennessee Valley Authority	Investigating Unipolar Capacitive Wireless Power Transfer Technology for the Wireless Charging of EV's (Phase I - Design)	Research Assistant Professor Charles Van Neste
Dipayan Banik	The University of North Carolina at Chapel Hill (Funding from NASA)	Tracking Water Storage in Lakes: Citizens and Satellites Implementation Phase	Professor Sheikh Ghafoor
Dipayan Banik	Oak Ridge National Laboratory	MIMIR/MEASUR: A Live Dashboard Project for Industrial Devices	Chairperson Gerald Gannod
Adam Becklehimer	Industrial Sponsor	Application of Artificial Intelligence for Air Pollution Monitoring and Remediation using Neural Network and Deep Learning	Assistant Professor Ahmad Vasselbehagh
Brian Bowman	Center for Energy Systems Research, Tennessee Technological University	Comparing Strength and MOE for Prisms Constructed with Lightweight and Normal Weight Grout	Professor Craig Henderson
Ann Brewer	Case Western Reserve University	Novel Endogenous Beta Defensin Based Therapeutics to Treat COVID-19 Patients	Assistant Professor Liqun Zhang
Levi Carroll	National Science Foundation	EAGER SitS: A Multi-Sensor Probe Network for Continuous Monitoring of the Soil Health	Research Assistant Professor Charles Van Neste

# UNDERGRADUATE RESEARCH PROJECTS, continued SM-11

Undergraduate Student	Sponsor	Program	Faculty Advisor
Glen Cathey	Oak Ridge National Laboratory	MIMIR/MEASUR: A Live Dashboard Project for Industrial Devices	Chairperson Gerald Gan-nod
Matthew Crispi	Industrial Sponsor	Development of Unified Duct Design Equations and Improvements to the Current FEA Model	Professor Jane Liu and Professor Stephen Idem
Matthew Crispi	Industrial Sponsor	Measurement of Unreinforced and Reinforced Spiral Flat Oval Duct Deformation under Positive and Negative Pressure	Professor Stephen Idem and Professor Jane Liu
Grant Crumpton	Miami University (Funding from the Tennessee Department of Health)	Implementing a Preference-Based, Person-Centered Communication Tool in Tennessee	Chairperson Gerald Gan-nod
Viviana Cruz	National Science Foundation	REU Site: Immersive Research in Energy Generation, Storage/ Conversion, and Power Transmission	Principal Investigator Indranil Bhattacharya, Professor Holly Stretz
Rachel Cullison	Department of Energy	The Structure of Neutron-rich Deformed Nuclei Studied via Beta Decay	Associate Professor Mustafa Rajabali
Andrew Davis	Center for Energy Systems Research, Tennessee Technological University	Aerodynamics of Damaged Wings	Assistant Professor Ahmad Vasselbehagh



# UNDERGRADUATE RESEARCH PROJECTS, continued SM-11

Undergraduate Student	Sponsor	Program	Faculty Advisor
Sean Denn	Tennessee Valley Authority	Investigating Unipolar Capacitive Wireless Power Transfer Technology for the Wireless Charging of EV's (Phase I - Design)	Research Assistant Professor Charles Van Neste
Samuel Dunham	Industrial Sponsor	Development of Unified Duct Design Equations and Improvements to the Current FEA Model	Professor Jane Liu and Professor Stephen Idem
Adrianna Eastep	Case Western Reserve University	Novel Endogenous Beta Defensin Based Therapeutics to Treat COVID-19 Patients	Assistant Professor Liqun Zhang
Pedro Garza-Ramos	External University Sponsor	Demonstrate Enhancement of Heat Transfer in Important Components of Grid Operations	Assistant Professor Ethan Languri
Nathan Ghattas	National Science Foundation	REU Site: Immersive Research in Energy Generation, Storage/ Conversion, and Power Transmission	Principal Investigator Indranil Bhattacharya, Associate Professor Steven Anton
Samuel Hollifield, Jr.	Oak Ridge National Laboratory	From Can't to Can: Attack Prevention and In-Situ Detection of Advanced Attacks on Controller Area Networks	Professor Sheikh Ghafoor
Robert Hughes	Tennessee Concrete Association	Going Beyond ACI 332: Commercial/Residential Enhanced Durability: Phase II What If?	Professor Lewis K. Crouch

# UNDERGRADUATE RESEARCH PROJECTS, continued SM-11

Undergraduate Student	Sponsor	Program	Faculty Advisor
Sean Jones	Center for Energy Systems Research, Tennessee Technological University	Testing Silicon Detectors with an Alpha Source and Designing and Implementing a Control System for a Stepper Motor Assembly	Associate Professor Mustafa Rajabali
Brandon T. Kemp	Miami University (Funding from the Tennessee Department of Health)	Implementing a Preference-Based, Person-Centered Communication Tool in Tennessee	Chairperson Gerald Gannod
Aaron Kindred	Department of Energy	The Structure of Neutron-rich Deformed Nuclei Studied via Beta Decay	Associate Professor Mustafa Rajabali
Whitney Kirby	Tennessee Valley Authority	Investigating Unipolar Capacitive Wireless Power Transfer Technology for the Wireless Charging of EV's (Phase I - Design)	Research Assistant Professor Charles Van Neste
Evan Kixmiller	Tennessee Valley Authority	High Energy Lithium/Sodium Ion Batteries for Grid Level Energy Storage - Phase I	Associate Professor Indranil Bhattacharya
Sung Kyung Lee	Department of Energy	The Structure of Neutron-rich Deformed Nuclei Studied via Beta Decay	Associate Professor Mustafa Rajabali
Benjamin K. Luna	Department of Energy	The Structure of Neutron-rich Deformed Nuclei Studied via Beta Decay	Associate Professor Mustafa Rajabali

# UNDERGRADUATE RESEARCH PROJECTS, continued SM-11

Undergraduate Student	Sponsor	Program	Faculty Advisor
Tyler Marcum	Tennessee Valley Authority	Investigating Unipolar Capacitive Wireless Power Transfer Technology for the Wireless Charging of EV's (Phase I - Design)	Research Assistant Professor Charles Van Neste
Richard Mitchell	Department of Energy	The Structure of Neutron-rich Deformed Nuclei Studied via Beta Decay	Associate Professor Mustafa Rajabali
Joshua Nichols	Industrial Sponsor	Application of Artificial Intelligence for Air Pollution Monitoring and Remediation using Neural Network and Deep Learning	Assistant Professor Ahmad Vasselbehagh
Brandon Nieman	National Science Foundation	EAGER SitS: A Multi-Sensor Probe Network for continuous Monitoring of the Soil Health	Research Assistant Professor Charles Van Neste
Alexander Palentyn	Center for Energy Systems Research, Tennessee Technological University	Development of Unified Duct Design Equations and Improvements to the Current FEA Model	Professor Jane Liu
Mackenzie Pugh	Oak Ridge National Laboratory	Nuclear Hybrid Energy Systems: Desalination and Wastewater Reclamation Process Modeling	Assistant Professor Laura Arias Chavez
George Rucker	Industrial Sponsor	Advanced Metal Anodes for Lithium Metal Secondary Batteries	Assistant Professor Liqun Zhang

<b>Undergraduate Student</b>	<b>Sponsor</b>	<b>Program</b>	<b>Faculty Advisor</b>
Cameron Schaff	Industrial Sponsor	Development of Unified Duct Design Equations and Improvements to the Current FEA Model	Professor Jane Liu and Professor Stephen Idem
Cameron Schaff	Industrial Sponsor	Measurement of Unreinforced and Reinforced Spiral Flat Oval Duct Deformation under Positive and Negative Pressure	Professor Stephen Idem and Professor Jane Liu
William Stump	Tennessee Valley Authority	Investigating Unipolar Capacitive Wireless Power Transfer Technology for the Wireless Charging of EV's (Phase I - Design)	Research Assistant Professor Charles Van Neste
William Stump	External University Sponsor	Adaptive and Reconfigurable Sensor Elements and Networks for Monitoring Critical Infrastructure and Maneuver Corridors	Research Assistant Professor Charles Van Neste
Kaylalyn Truman-Jarrell	Tennessee Valley Authority	Investigating Unipolar Capacitive Wireless Power Transfer Technology for the Wireless Charging of EV's (Phase I - Design)	Research Assistant Professor Charles Van Neste
Kaylalyn Truman-Jarrell	National Science Foundation	EAGER SitS: A Multi-Sensor Probe Network for Continuous Monitoring of the Soil Health	Research Assistant Professor Charles Van Neste
Allison Vance	Center for Energy Systems Research, Tennessee Technological University	Comparing Strength and MOE for Prisms Constructed with Lightweight and Normal Weight Grout	Assistant Professor Ahmad Vasselbehagh

Undergraduate Student	Sponsor	Program	Faculty Advisor
Jeffrey B. Yeates	National Science Foundation via the University of Tennessee at Knoxville	MRI: Development of a High Resolution Neutron Detector for Decay and Reaction Studies with Exotic Nuclei	Associate Professor Mustafa Rajabali
Jonathan Zigler	National Science Foundation	REU Site: Immersive Research in Energy Generation, Storage/ Conversion, and Power Transmission	Principal Investigator Indranil Bhattacharya, Associate Professor J. W. Bruce

**Total Count: 39**

ACTUAL, PROPOSED, AND REQUESTED BUDGET SCHEDULE 7

Schedule 7

CENTERS OF EXCELLENCE ACTUAL, PROPOSED, AND REQUESTED BUDGET

	FY 2019-20 Actual		FY 2020-21 Proposed		FY 2021-22 Requested	
	Matching	Appropri.	Matching	Appropri.	Matching	Appropri.
<b>Expenditures</b>						
<b>Salaries</b>						
Faculty	\$421,115	\$125,459	\$164,494	\$421,907	\$104,023	\$335,507
Other Professional	\$133,668	\$99,744	\$4,116	\$302,477	\$5,693	\$145,271
Clerical/ Supporting	\$0	\$44,123	\$0	\$103,286	\$0	\$80,111
Assistants	\$371,661	\$281,244	\$100,609	\$318,644	\$143,155	\$140,000
<b>Total Salaries</b>	<b>\$926,464</b>	<b>\$550,580</b>	<b>\$289,219</b>	<b>\$1,146,314</b>	<b>\$252,871</b>	<b>\$700,889</b>
Fringe Benefits	\$277,998	\$202,993	\$62,396	\$483,306	\$99,796	\$230,000
<b>Total Personnel</b>	<b>\$1,204,462</b>	<b>\$753,573</b>	<b>\$331,615</b>	<b>\$1,629,620</b>	<b>\$352,607</b>	<b>\$930,889</b>
<b>Non-Personnel</b>						
Travel	\$68,766	\$15,323	\$42,968	\$45,825	\$35,661	\$15,000
Software		\$1,992		\$1,500		\$500
Books & Journals	\$977			\$300		\$0
Other Supplies	\$113,289	\$49,614	\$28,809	\$100,320	\$21,660	\$34,511
Equipment	\$88,881	\$11,727	\$49,071	\$28,321	\$37,285	\$5,000
Maintenance		\$0		\$0		\$0
Scholarships		\$0		\$0		\$0
Consultants	\$126,632	\$500	\$4,500	\$500		\$500
Renovation		\$0		\$0		\$0
Other (Specify):		\$0		\$0		\$0
Participant Support Costs	\$275,905		\$36,237		\$45,987	
<b>Advertising Expense</b>		\$529		\$300		\$0
<b>Total Non-Personnel</b>	<b>\$674,350</b>	<b>\$79,685</b>	<b>\$161,685</b>	<b>\$177,066</b>	<b>\$140,693</b>	<b>\$55,511</b>
<b>GRAND TOTAL</b>	<b>\$1,878,812</b>	<b>\$833,258</b>	<b>\$493,200</b>	<b>\$1,806,686</b>	<b>\$493,200</b>	<b>\$986,400</b>
<b>Revenue</b>						
New State Appropriation		\$970,600		\$986,400		\$986,400
Carryover State Appropriation		\$669,876		\$820,286		\$0
New Matching Funds	\$1,878,812		\$493,200		\$493,200	\$493,200
Carryover from Previous Matching Funds		\$0				\$0
<b>Total Revenue</b>	<b>\$1,878,812</b>	<b>\$1,640,476</b>	<b>\$493,200</b>	<b>\$1,806,686</b>	<b>\$493,200</b>	<b>\$986,400</b>
						<b>\$1,479,600</b>

Institution: Tennessee Technological University Center: Center for Energy Systems Research



## JUSTIFICATION FOR 2021-2022 APPROPRIATIONS REQUEST

The Center for Energy Systems Research (CESR) is anticipating additional expenses during 2021-2022. The increased expenses include additional cost for personnel appointments of a new Research Assistant Professor, an additional Financial Associate, and funding for additional undergraduate and graduate students to participate in the research activities of the CESR. The carryover is sufficient to take care of the additional expenses.

Due to the economic impacts of the COVID-19 Pandemic, we are not requesting any funding increase for Fiscal Year 2021-2022. We plan to help the State of Tennessee and the nation as needed in our research areas of Smart Grid and Resilient Infrastructure and other needed areas to recover from and stop the spread of the COVID-19.

