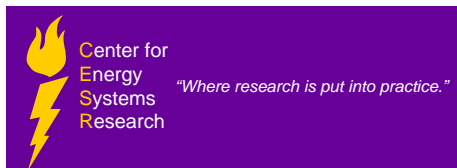


# THE CENTER FOR ENERGY SYSTEMS RESEARCH

TENNESSEE TECHNOLOGICAL UNIVERSITY



## ANNUAL REPORT FISCAL YEAR 2009 – 2010

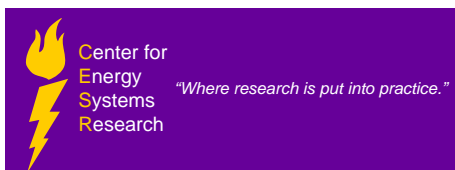


# Annual Report for Fiscal Year

JULY 1, 2009 – JUNE 30, 2010

**Sastry S. Munukutla, Director**

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



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**Cover Description:** [Dr. David Wenzhong Gao](#), winner of the [NSF Career Award](#), is pictured at his construction site of a solar array. The renewable energy solar power station consists of 240 solar PV panels with a total peak power of 12 Kilowatts. The facility is ideal for students' field trip and demonstration for practical solar power generation technologies. Graduate students will use the station for thesis research for renewable energy control and monitoring. This project reflects the current focus of the center on green energy through the study of solar, wind, smart-grids, and cleaner coal power production.

The Center's mission statement summarizes its overall purpose:

To advance and apply scientific and engineering knowledge associated with energy systems and in particular with electric power

## TABLE OF CONTENTS

### PROGRAMMATIC REPORT

CESR MISSION .....	1
MESSAGE FROM THE DIRECTOR.....	3
RESEARCH AREAS .....	5
2009-2010 FISCAL YEAR.....	7
CESR RESEARCH FUNDING 1985 THRU 2010 .....	7
RESEARCH HIGHLIGHTS .....	8
AWARDS AND ACCOMPLISHMENTS 2009–2010 .....	13
STUDENT ACCOMPLISHMENTS AND AWARDS 2009–2010 .....	14
CONFERENCES ATTENDED BY FACULTY AND SUPPORT STAFF .....	15

### PLANS FOR 2010-2011

PLANS FOR 2010-2011.....	19
--------------------------	----

### SUPPORTING MATERIALS

SUPPORT STAFF	SM-1	.....	23
FACULTY PARTICIPATION	SM-2	.....	25
CONTRACT AND GRANT AWARDS	SM-3	.....	31
STATUS OF PROPOSALS	SM-4	.....	35
STATUS OF PROPOSALS	SM-5	.....	40
PUBLICATIONS	SM-6	.....	45
BOOKS, BOOK CHAPTERS		.....	51
INVITED PARTICIPATION	SM-7	.....	52
PROFESSIONAL SERVICE	SM-8	.....	53
VISITORS	SM-9	.....	58
SEMINAR SERIES	SM-10	.....	59
CESR GRADUATES	SM-11	.....	60
CESR GRADUATES	SM-11	.....	61
CESR GRADUATES	SM-11	.....	63
GRADUATE STUDENT SUPPORT	SM-12	.....	64
GRADUATE STUDENT SUPPORT	SM-12	.....	65
HOURLY STUDENT PERSONNEL	SM-13	.....	66
GRADUATE STUDENT SUPPORT	SM-12	.....	64
GRADUATE STUDENT SUPPORT	SM-12	.....	65
HOURLY STUDENT PERSONNEL	SM-13	.....	66

## BUDGET MATERIALS

ACTUAL, PROPOSED, AND REQUESTED BUDGET	SCHEDULE 7 .....	71
SCHEDULE 13A	ACTUAL PERSONNEL .....	73
SCHEDULE 13B	PROPOSED PERSONNEL .....	74
SCHEDULE 13C	REQUESTED PERSONNEL .....	75
SCHEDULE 14A	2009-2010 PURCHASED EQUIPMENT .....	76
SCHEDULE 14B	PROPOSED EQUIPMENT .....	77
SCHEDULE 14C	REQUESTED EQUIPMENT .....	78
SCHEDULE 15A	BASE SUPPORT & NON EQUIPMENT MATCHING.....	79
SCHEDULE 15B	PROPOSED BASE SUPPORT & NON- EQUIPMENT MATCHING .....	82
SCHEDULE 15C	REQUESTED BASE SUPPORT & NON-EQUIPMENT MATCHING .....	83

## PROGRAMMATIC REPORT

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Dr. Holly Stretz was presented the American Society for Engineering Educators (ASEE) Southwestern Section New Faculty Research Award

April 2010 by Dr. Donald Visco, Professor Chemical Engineering

(Photo courtesy of Dr. Stretz)



## **CESR 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.

Research efforts, both theoretical and experimental, are focused on solving current and anticipated problems associated with energy systems. Special emphasis is given to the needs of the electric power industry.

The Center, which is administered through the College of Engineering, provides opportunities for interdisciplinary research, by involving faculty, staff, and students throughout the University. The Center has a positive impact on many facets of the electric power industry in the state of Tennessee and the nation.

### **Vision**

The Center's vision is to enhance education and research throughout the world in the area of electric power.

### **Scope of the Program**

CESR operates within the TTU System. The Center draws upon the expertise from the Engineering College faculty as well as from other faculty on campus. Participating faculty and faculty associates represent Chemical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, Mathematics, Mechanical Engineering and Manufacturing and Industrial Technology. Support in the form of travel money and graduate student support is provided to faculty members to encourage them to submit proposals through the Center, where needed support for marketing research concepts is also provided.





# PROGRAMMATIC REPORT

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## MESSAGE FROM THE DIRECTOR

### YEAR IN REVIEW

The Center has completed 25 years of existence as of the end of FY 2009-2010. I served as a faculty member housed in the Center for 14 years from 1986-2000 and as the Director for 10 years from 2000-2010. I am leaving my affiliation with the Center and joining the Department of Mechanical Engineering as a full-time Professor starting August 1, 2010.

It is my pleasant duty to review the financial aspects of the Center during the last 25 years. Table I shows the state appropriation vs. the external funding generated by the Center for each of the 25 years. The highest state appropriation of \$1,093,496 was received during 1986-1987 and the lowest of \$741,100 was received during 1991-1992. The average state appropriation during the entire 25 years is \$890,717. The lowest external funding of \$331,747 was received during 1986-87 and the highest of \$2,093,097 was received during 2005-2006. The 25 years average external funding is \$900,172. The ratio of external funding to the state appropriation during the 25 year period is 1.01. The mandated ratio when the Centers were established was 0.5. Thus it can be seen that the Center generated almost twice of what it was mandated to generate.

I would now take the opportunity to examine the financial performance of the first 15 years (1985-2000) compared to the last 10 years (2000-2010) during which time I was Director. The average state appropriation from 1985-2000 is \$876,535. The average state appropriation from 2000-2010 is \$911,990. The increase in state appropriation from the first 15 years to the last 10 years is an insignificant 2.39%. The average external funding from 1985-2000 is \$615,778 while the same from 2000-2010 is \$1,326,763. The increase in external funding from the first 15 years to the last 10 years is 115.46%. The average external funding thus increased by a factor of 2.15.

During the first 15 years from 1985-2000 the role of the Director was considered as that of a Manager. Faculty associates approached the Center Director only when they decided to initiate a research project. However, when I became Director in May 2000 Dean Johnson charged me with two major responsibilities. The first is to "lead by example" and the second is to increase the federal funding component. I want to show my appreciation to Dr. Johnson for his vision and also the extraordinary support that I received from him during my formative years as Director. I pursued my own funded projects in the power plant performance monitoring area and other related areas thus leading by example. The faculty associates activated several federal projects from agencies such as NASA, DOE, US Army, US Navy and NSF. In addition, I worked very closely with faculty associates at all stages of their funded research. I spent time understanding the skills of each individual and on many occasions I brought funding opportunities to their attention for them to move forward. The success of this strategy can be judged by examining Tables I and II. From Table I it can be seen that the external funding has crossed the \$1 million mark for each of the last five years. From Table II it can be seen that during my tenure as Director the average external funding increased by a factor of 2.15. It has been a pleasure working with nearly 20 faculty associates over the 10 year period.

I would like to close my message by showing appreciation to the staff of our Center. In my opinion and in the opinion of several of our faculty associates the staff of CESR is one of the best on campus. They have played a very large role in the success of the Center.



Sastry Munukutla, Director CESR, was presented the 2010 Outstanding Faculty Award in Professional Service by TTU President, Bob Bell



# PROGRAMMATIC REPORT

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## RESEARCH AREAS

Research contract and grant awards activated from July 1, 2009 thru June 30, 2010 total \$1,390,877. The distribution among the Center for Energy Systems Research (CESR) areas of research is shown in the following table.

Research Area	Activated Amount
Power Systems Performance Improvement	\$676,990
Environmental Issues and Energy Conservation	\$137,109
Advanced Technologies	\$484,034
Service Account	16,044
Miscellaneous Contracts	76,700
Total Activated Amount	\$1,390,877

CESR continues to enjoy a broad base of support. The funding categories for 1985 thru 2010 as illustrated in Figure 1 are: in-state utilities, 14.8 percent; out-of-state utilities, 8.05 percent; state and local agencies, 11.24 percent; federal government, 50.73 percent; other, 15.18 percent. The "other" category includes a variety of national and international industries, universities and professional societies. Through June 2010, the cumulative research funding of the Center is \$22,479,520.

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 25-year match of about \$22.5 million represents 101.2 percent of the state appropriations of \$22.2 million. Indirect costs of approximately \$4.05 million have also been received. The 2009-2010 match is \$1,390,877 and the state appropriation is \$931,000. A list of the projects conducted under the major research areas is given in SM-3 in this report.



## 2009-2010 FISCAL YEAR

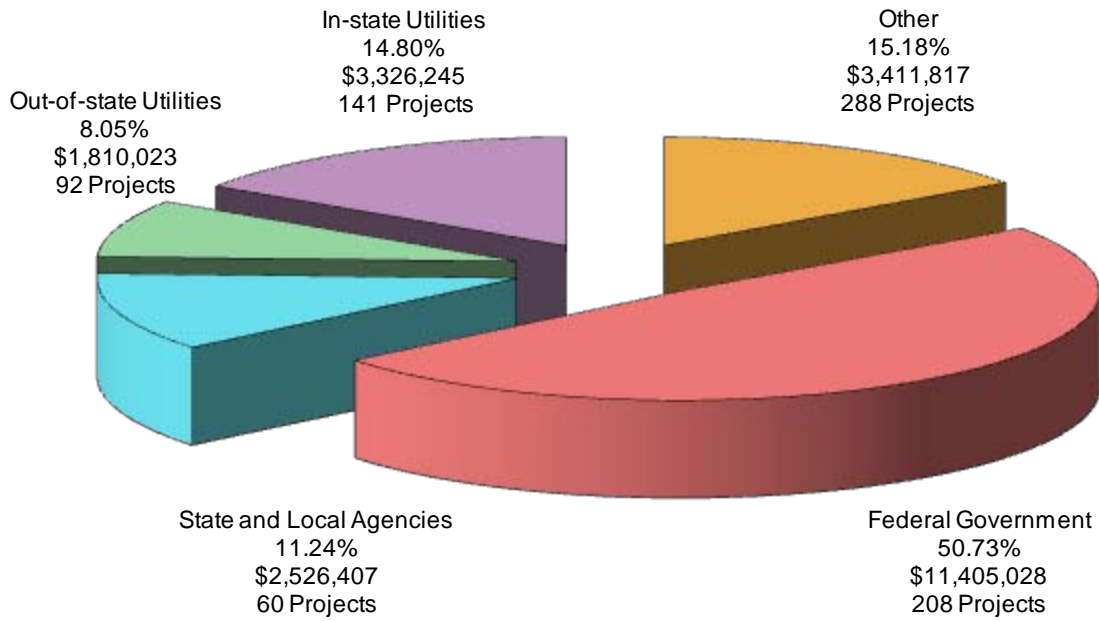


Figure 1: Types of Research Funding (Total \$22,479,520)

## CESR RESEARCH FUNDING 1985 THRU 2010

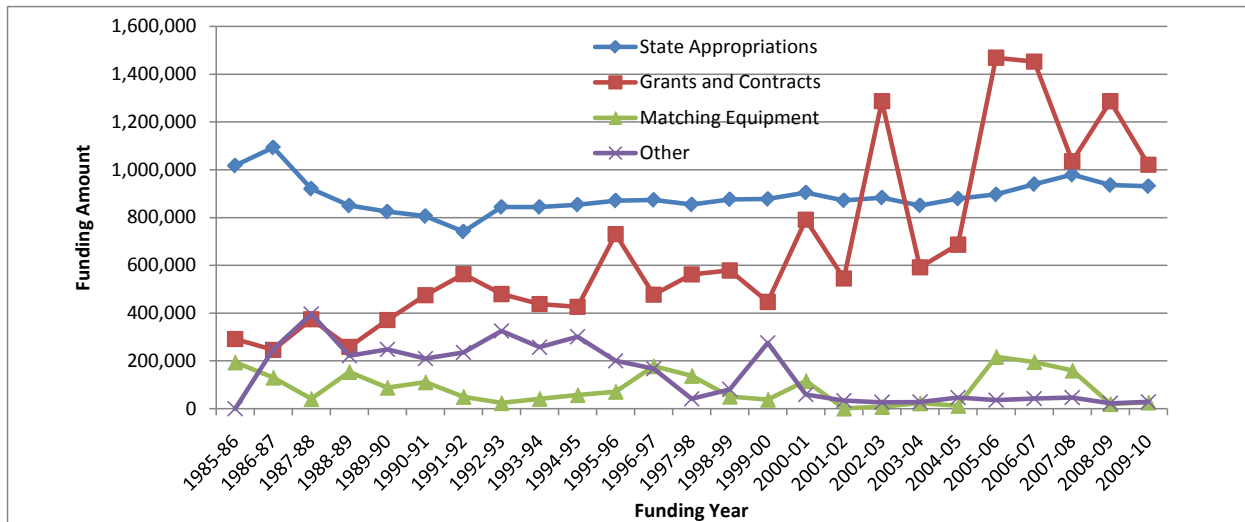


Figure 2: Historical State Appropriations and Matching

## RESEARCH HIGHLIGHTS

### CENTER FOR ENERGY SYSTEMS RESEARCH FACILITIES OVERVIEW

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Professors and graduate students performing research with the Center for Energy Systems Research (CESR) can draw upon the many labs and resources of the university, college, and various departments. In addition to these facilities the center has several resources that may prove useful for new research endeavors.

#### SOLAR RESEARCH

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Figure 1 shows the first solar power generation installation at TTU. It will serve as the genesis of new hybrid power circuits designed by student researchers.



Figure 1 CESR Solar research.

#### WIND POWER

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Motors serving as prime movers instead of wind turbines, coupled with generators provide a computer controlled wind generation system for students to research the power electronics for most efficient utilization of various speed winds. This research can be coupled with solar cells for multiple source hybrid generation electronics development.

An actual wind turbine (currently in the lab) installation will provide a test platform for new control strategies.

#### HYBRID FUEL CELL AND ENERGY STORAGE

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A Nexa 1.2 kW Training System and Hampden 50 W Fuel Cell Technology Trainer provide the foundation for CESR fuel cell research. The programmable nature of these systems let them serve as test beds for new control circuitry and algorithm development. Additional test equipment, batteries, and ultra capacitors provide many educational and research opportunities. The initial offshoot research program from this laboratory is the development of a fuel cell powered scooter.

#### REAL-TIME DIGITAL SIMULATOR

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The Real-Time Digital simulator (RTDS) can solve power system equations fast enough to continuously produce output waveforms and status that realistically represent conditions in a real network. It is a powerful tool for conducting simulations with hardware in the loop. Currently, a SEL protection relay system together with the RTDS is used to analyze faults on power systems. Additionally, the RTDS is used to perform simulations of different control strategies for wind power generation.

#### LABGRID

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A laboratory sized power grid provides a physical model for research and testing. Several generators serve to model similar generators in the “real” power grid while discrete lumped electronic components simulate transmission lines. Lights and fans serve as resistive and inductive loads. The lab provides a

platform for verifying simulation models on a small scale to establish confidence in modeling techniques employed on larger simulated grids.



Figure 2 Labgrid pictured with two generators a transmission line and data acquisition system.

## **TVA POWER RELAY LAB**

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The TVA Power Relay Lab is a 477 sq. ft. lab equipped with state-of-the-art protective relay systems. The list of brands includes names of leading industry manufacturers such as: Siemens, ABB, SEL, and Schneider Electronic. For research and education purposes, relay systems include: Distance Protection, Over Current Protection, Transformer Protection, Generator Protection, Numerical Current Comparison Protection, Multifunction Digital Protection, Circuit Breaker Simulators, etc. These systems provide unique research and education opportunities in substation protection, monitoring, control and automation.

As a part of our ongoing research using the relay equipment we implemented the Generic Object Oriented Substation Event (GOOSE) protocol with RuggedCom network switches, relays, Omicron test set, and ABB circuit breaker simulator. This GOOSE testing platform has been used for a senior Capstone design project and was successfully demonstrated.

## **COMPUTER HARDWARE**

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Matlab Distributed Computing Engine – eight parallel channels.

Three dual quad-core Xeon workstations currently dedicated to CFD research.

Two NI PXI bus data acquisition systems plus numerous USB devices.

Two workstations with dSpace signal processors for Power Systems Simulations.

36 PCs dedicated to graduate student research.

Network printers conveniently located throughout CESR facilities, including a 50 ppm laserjet with output sorting.

File Servers. Up to 1.2 TB secure, backed up file storage is available to Faculty, Staff, and students.



## COMPUTER SOFTWARE

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Fluent and Gambit; Siemens PSS/E; Matlab; Tecplot; National Instruments LabView and Signal Express; MS Office 2007; MS Visio Professional; Fortran Compiler; MS Visual Studio; PSCAD.

## FACULTY RESEARCH

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### Sabine Leborne

Research project information for CESR annual report on NSF Report #0913017, PI: Sabine Le Borne

The numerical simulation of flow problems requires the efficient solution of linear systems of equations of saddle point type. In this project, a new approach based on an approximate inverse has been developed and compared to existing techniques. This research enhances the numerical linear algebra techniques for analysing matrix preconditioners.

The research resulted in a joint paper with a former TTU graduate student, Che Ngufor, accepted for publication in the journal "Electronic Transactions on Numerical Analysis". Two undergraduate students have worked on individual research projects, and one of those students presented a poster on the Induced Residual Reduction (IDR) method at the TTU Student Research Day in April 2010.

### Ambareen Siraj

Reactive and real-time wide area monitoring systems (WAMS), such as the Frequency Monitoring NETWORK (FNET) originally developed at Virginia Tech, allow for the gathering of frequency data throughout the entire power grid. Since security is a key objective in the smart grid project, these concerns must be addressed. Currently we have been working to strengthen FNET against harmful cyber-attacks. Introducing systems such as FNET to the Internet opens up the possibility for attackers to abuse vulnerabilities inherent in the current system. In our project we are developing a layered Defense in Depth strategy to better secure FNET from such threats. We have also been investigating the potential use of a technique known as chaffing and winnowing to help achieve confidentiality, integrity, and freshness of data in the communications between the remote sensors and central database server.

This research has resulted in a paper written by TTU graduate student Joseph McDaniel titled "Towards a Secure Frequency Monitoring Network (FNET) System." The paper details vulnerabilities inherent in the current FNET system as well as ways to mitigate the threats of these vulnerabilities. Also, this paper introduces a layered Defense in Depth strategy currently under development. This paper was published at the 6th Cyber Security and Information Intelligence Research Workshop (CSIIIR 10) in Oak Ridge National Lab, Oak Ridge. Also, a poster containing this information was presented at the TTU Student Research Day in April 2010. An undergraduate student, Daniel White, was able to actually implement attacks directed towards the vulnerabilities found in FNET and documented his results in a technical report titled, "Hacking the Frequency Monitoring NETWORK (FNET) System: Reflections and Recommendations".

### Holly Stretz

Research project information for year 2009-2010--Outcomes of the work that was carried out as part of research for year 2009-2010 are as follows:

Proposals-

- Career Proposal: "Nanoparticle Barrier Layers: Strengthening the Network," NSF, H. A.
- Stretz, \$526,220/5 years, *not funded* but got good reviews and was recommended for funding.
- "TA Instruments AR-550 Rheometer for Interdisciplinary Undergraduate/Graduate
- Laboratory Enhancement, TTU Engineering Development Fund, *Funded*.(see figure 1)
- Another new career proposal is in draft which will be submitted by July 2010.



Figure 1: TA Instruments AR-550 Rheometer

**Publications:**

Fox, B., Ambuken P.V., Stretz, H. A., Payzant, A., Meisner, R., "Organoclay barrier layers formed by combustion: Nanostructure and permeability," submitted to *Applied Clay Science*, 06-2010, Article in Press.

**Collaboration:**

Editing and updating "Lee, S. M., *International Encyclopedia of Composites*. December 1991;Vol. 6." in collaboration with Martin Tant from Eastman Chemical Company.

**Research Projects:**

To provide validation for early transport models, the structure of model barrier layers was investigated, these being produced by combustion of a homologous series of organomontmorillonites. The effects of compatibilizer structure, temperature and pressure on barrier layer structure were examined. It was found that addition of subtle pressure at moderate temperatures altered the barrier layer structure, but not uniformly.  $M_2(HT)_2$  and  $M_2(Alk)_2$  subjected to moderate pressure produced a new "expanded" phase, where  $M(HT)_3$  and  $M_3(HT)$  both exhibited a collapsed phase under the same pressure. Permeability analysis on these barrier layers were also carried out to obtain the flux. The pressure degraded  $M_2(HT)_2$  ash showed a higher flux of Ar permeant than the pristine  $M_2(HT)_2$ .

The physical barrier layer of inorganic reinforcement/carbonaceous char imparts unique thermal and transport-resistant protection to the overall system. This fragile phase has nano-scale components, but must remain intact on a meso-scale in order to continuously perform. In addition, in certain cases (such as in the development of aerospace ablatives) the char must withstand enormous shear forces. While a compelling need for tougher chars has been established, an understanding of mechanical stability of typical nano-reinforced chars has not yet been fully developed in the literature.

Polypropylene-Polyhedral Oligomeric Silsesquioxane (POSS) nanocomposites have been synthesized to study the barrier layer in combination with polymer. The Polyhedral Oligomeric Silsesquioxanes (POSS) are an interesting class of three-dimensional inorganic/organic hybrids with the generic formula of  $(RSiO_{3/2})_n$ , as shown in Fig. 2. POSS molecules with well-defined shapes and sizes ranging from 1–3 nm have been described as the smallest version of colloidal silica.

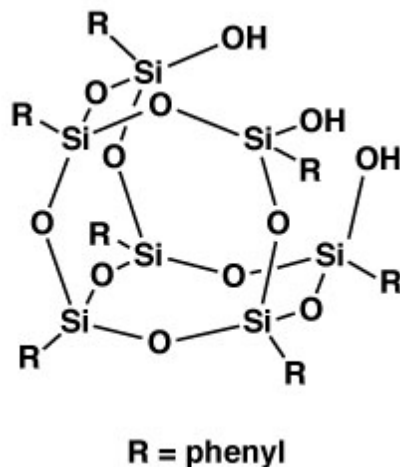


Figure 2: Schematic structure of Trisilanol Phenyl POSS

Graphene nanoparticles will also be synthesized by natural flake graphite. Firstly, modified Hummers method will be used to make graphite oxide and then this graphite will be fully exfoliated by rapid heating in tube furnace. These graphene nanoparticles will be used to make Polypropylene Graphene nanocomposites. [1-3]

All Polymer Nanocomposites will be precharred in a furnace as shown by Koo et al. [4] This charred material will be tested for mechanical resistance at room temperature using AR-550 Rheometer as described by Bodzay et al. [5] and Jimenez et al.[6]

#### References:

1. Hummers, W. & Offeman, R. Preparation of graphitic oxide. *Journal of American chemical society* 80, 1339 (1958).
2. Schniepp, H. C., Li, J.-L., McAllister, M. J., Sai, H., Herrera-Alonso, M., Adamson, D. H., Prud'homme, R. K., Car, R., Saville, D. A. & Aksay, I. A. Functionalized Single Graphene Sheets Derived from Splitting Graphite Oxide. *Journal of Physical Chemistry Letters B* 10, 8535-8539 (2006).
3. Stankovich, S., Piner, R. D., Nguyen, S. T. & Ruoff, R. S. Synthesis and exfoliation of isocyanate-treated graphene oxide nanoplatelets. *Carbon* 44, 3342-3347 (2006).
4. Ho, W. K., Koo, J. H. & Ezekoye, O. A. Thermoplastic Polyurethane Elastomer Nanocomposites: Morphology, Thermophysical, and Flammability Properties. *Journal of Nanomaterials*, doi:doi:10.1155/2010/583234 (2010).
5. Bodzay, B., Bocz, K., Bárkai, Z. & Marosi, G. Influence of rheological additives on char formation and fire resistance of intumescent coatings. *Polymer Degradation and Stability* Article in Press (2010).
6. Jimenez, M., Duquesne, S. & Bourbigot, S. Multiscale Experimental Approach for Developing High-Performance Intumescent Coatings. *Ind. Eng. Chem. Res.* 45, 4500-4508 (2006).

**Sastry Munukutla: TTU's 2010 Outstanding Faculty Award in Professional Service**

Munukutla has worked hard to bring national and international recognition to TTU since he joined the university in 1986 as director for the Center for Energy Systems Research and as a professor of mechanical engineering. He teaches courses in fluid thermal sciences and conducts research in areas of applied thermodynamics and energy conversion processes, laser diagnostics and wind tunnel measurements. Munukutla has been a leader in the development of innovative methods to improve power plant performance and actively participated in many highly regarded international conferences where his knowledge was disseminated. His scholarly contributions to the university as a teacher and researcher are quite evident.

As a leader at the Center of Excellence for Electric Power, one of Munukutla's primary responsibilities is to bring externally funded research projects to TTU. Toward that end, he organized a major marketing trip to electric utilities in Pennsylvania, Virginia, New Jersey, Ohio and North Carolina in the fall of 1986 and over the years served as principal investigator on projects totaling nearly \$2.7 million. The number of sponsors, including international companies, for his projects totals 32.

**(David) Wenzhong Gao received the NSF Career Award** for his research and education in wind power. The NSF Career award is among the most prestigious awards made through NSF. It is granted to support the early career development activities of scholars who most effectively integrate research and education in their disciplines. The NSF Career award recognizes Dr. Gao as an excellent researcher, outstanding educator and a future leader in the power and energy field.

**Dr. Holly Stretz** was presented the American Society for Engineering Educators (ASEE) Southwestern Section New Faculty Research Award, April 2010

**Dr. Stephen Canfield and Dr. Mohamed Abdelrahman share the 2010 TTU Sissom Award.**

The Sissom award recognizes scholarship, methodology, invention, technique and other contributions within TTU's College of Engineering and honors Leighton E. Sissom, former dean of TTU's College of Engineering.

**Dr. Joseph Biernacki and Dr. Mohamed Abdelrahman win 2009 Caplenor Award**

The award, first presented in 1984, is the university's premier research award and is named in honor of Donald Caplenor, former associate vice president for research and dean of instructional development who died in 1979. (**Abdelrahman**, ECE, specializes in high-tech metal casting research, partnering with the likes of the American Foundry Society, General Motors, Hitchner, Foseco-Morval and Oak Ridge National Laboratory. **Biernacki**, ChE, is one of the few chemical engineers in the world who is working on Portland cement-based materials. His research interests involve novel methods for characterization of chemical reaction phenomena and mechanical response of Portland cement.)

**Dr. Stephen Canfield** was chosen to receive the **2010 Rep. Harold Love Outstanding Community Service Award** presented by the Tennessee Higher Education Commission for his dedication to the Early Intervention and Mechanical Engineering (EIME) project at TTU.

## STUDENT ACCOMPLISHMENTS AND AWARDS

2009–2010

CESR Graduate Students **Vadim Zheglov, Andrew Watkins, Ganapathy Kumar and Anuradha Kumar** received awards at TTU's Student Research Day: The awards consisted of a monetary award of \$50, a bronze research day medallion and a certificate of appreciation.

**North American Power Symposium (NAPS)** awarded travel grants for the amount of \$75 to conference attendees **Nassar Keshmiri, Aboli Kulkarni, Jiaxin Ning, Andrew Watkins and Vadim Zheglov**.



Photo courtesy of Vadim Zheglov

**STUDENT RESEARCH DAY** at Tennessee Technological University is an event designed to showcase in a poster format the research of students.

## CONFERENCES ATTENDED BY FACULTY AND SUPPORT STAFF

### Robert Craven

Presentation of Technical Publication at ASME Power 2009 Conference in Albuquerque, New Mexico, July 2009

### Omar Elkeelany

Goldkey Certification Training (Security Related Workshop) in Blue Springs, Missouri, February 2010

### (David) Wenzhong Gao

Presentation of paper at 2009 IEEE Power Engineering Society General Meeting in Calgary, Alberta, Canada, July 2009

Short course on the Integration and Interconnection of Wind Power Plants into Electric Power Systems at Wind Integration Group: Wind Generation in Power Systems in Charleston, South Carolina, September 2009

Presentation at 5<sup>th</sup> IEEE Vehicle Power and Propulsion Conference in Dearborn, Michigan, September 2009 with Research Assistants Vadim Zheglov, Jaixin Ning, Jianfu Fu and Abdulkadir Bedir

Power Factor Correction Capacitors Meeting: Understanding the Benefits & Learning How to Safely Apply Them in Nashville, Tennessee, August 2009

Presentation at North American Power Symposium 2009 as session chair in Starkville, Mississippi, October 2009 with Research Assistants Vadim Zheglov, Nasser Keshmiri, Aboli Kulkarni and Andrew Watkins

North American SynchroPhasor Initiative Working Group Meeting in Chattanooga, Tennessee, October 2009 with Robert Craven, R&D Engineer and Research Assistant, Jiixin Ning

### Stephen Idem

Presentation at ASHRAE 2010 Annual Meeting in Albuquerque, New Mexico, June 2010

### Sastry Munukutla

Invited participant at workshop on "Improving the Efficiency of Coal-Fired Power Generation in the United States" in Baltimore, Maryland, February 2010

### Mahesh Panchagnula

Presentation at American Physical Society Division of Fluid Dynamics 62<sup>nd</sup> Annual Meeting in Minneapolis, Minnesota, November 2009 with Research Assistant Bharadwaj Prabhala

RSC Conference: Faraday Discussion 146: Wetting Dynamics of Hydrophobic and Structured Surfaces, in Richmond, Virginia, April 2010

### Ambareen Siraj

Industrial Control Systems Joint Working Group 2010 Spring Conference in San Antonio, Texas, April 2010

Presentation at Annual Cyber Security and Information Intelligence Research Workshop in Oak Ridge, Tennessee, April 2010 with Research Assistant, Joseph McDaniel

### Holly Stretz

American Chemical Society National Meeting Fall 2009 National Meeting and Exposition in Washington, DC, August 2009

American Institute of Chemical Engineers National Conference in Nashville, Tennessee, November 2009



## FUTURE PLANS

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### **Solar Power Generation Grid**

(Dr. David Gao)

Photo courtesy of CESR





## PLANS FOR 2010-2011

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The Center will continue to create interdisciplinary research teams to meet the needs of the Center's sponsors. New and established engineering faculty and faculty associates from outside the College of Engineering will continue to participate in research. Also, collaboration with other universities will be continued. In addition, education and research throughout the world in the area of electric power will be enhanced by involving graduate students from the United States and abroad.

### *CESR Goals*

To contribute to ongoing research related to energy systems and be recognized as a national leader

To contribute to ongoing university instructional and research activities and educational outreach activities at the highest level possible

To contribute to technology transfer and thereby improve the quality of life of citizens

### *Power Systems Performance Improvement*

Smart grid research and development (solar, wind and battery power and interconnection with existing grid, smart grid security, FNET application for power system performance predictions and improvement, Microgrid Technology)

Coal-fired power plant performance monitoring in real-time

Environmental Issues and Energy Conservation

High volume flyash utilization for highway and building construction

Traffic engineering

Improved thermal insulation technologies

Performance improvement of HVAC systems

Reuse of industrial solid waste material

### *ADVANCED TECHNOLOGIES*

CFD and solid mechanics modeling application to industrial problems

Robotics application to power and other industries

Multi-phase open winding motors and permanent magnet machines actuated with dual multi-phase, multi-level converters

Modeling of electro-chemical systems

Combustion research

Nanotechnology application to material science

**Research goals** for 2010-2011 in the above-mentioned areas follow.

Smart grid research and development (solar, wind and battery power and interconnection with existing grid, smart grid security, FNET application for power system performance predictions and improvement, Microgrid Technology)

Coal-fired power plant performance monitoring in real-time

Utilize the full potential of the state-of-the-art Real-Time Digital Simulator (RTDS) and incorporate it into various research activities in the area of power systems performance improvement. Utilize the recently acquired current transformer laboratory facilities to study other types of transformers. Develop an intelligent load shedding scheme to improve power system stability by using FNET data. Extend research activities into the area of renewable energy. Continue working on modeling of batteries and extend the techniques to model fuel cells. Increase external funding above the two million dollar mark.

### **Investment in the Future**

Funds provided to institutions of higher education through The American Recovery and Reinvestment Act (ARRA) will be used for one-time projects that fit into the Center's mission and goals.

Develop a laboratory to study the effects on frequency in power systems

Develop fluid mechanics laboratory to include advanced flow measuring systems

Increase computational power by acquiring high-end work stations

### **Strategic Objectives**

As stated in the University Unit Strategic Planning section, the Center's strategic objectives include the following:

#### **Objective 1:**

Purchase a network file server at an estimated cost of \$11,000 and purchase a new Dell Optiplex 960 desktop computer for the Director's office

#### **Relationship to University Goals:**

**1.1** Promote and effectively communicate the positive impact of TTU on students, alumni, faculty, and community.

**3.2** Enhance student involvement to promote healthy social relationships, academic success and a sense of community within the university.

**3.4** Enhance the campus infrastructure to effectively support all programs and objectives.

**Action Plan:** Purchase the needed items above in the Fall 2010 Semester.

**Assessment:** Review the purchases from the Purchase Orders and Requisitions

#### **Objective 2:**

Provide funding to Ph.D. Engineering students to enable a minimum of 2 Ph.D. Engineering students to graduate in 2010-2011.

Relationship to University Goals:

**3.2** Enhance student involvement to promote healthy social relationships, academic success and a sense of community within the university

#### **Action Plan:**

Review the list of current Ph.D. students on CESR assistantships and determine their graduate target dates. Recruit a minimum of 1 new Ph.D. student on CESR assistantships.

#### **Assessment:**

Review the list of students that graduated during 2010-2011 that is provided by the Graduate School to determine whether a minimum of 2 Ph.D. students graduated during 2010-2011.

#### **Objective 3:**

Increase externally funded research through the Center for Energy Systems Research.

Relationship to University Goals:

**4.1** Stimulate activities that increase external funding and efficiency/cost saving through individual and unit incentives.

#### **Action Plan:**

Recruit a minimum of one additional faculty member from engineering or the sciences to participate in research projects. Identify a minimum of one new funding source.

#### **Assessment:**

Review the list of faculty participants (SM-2) listed in the Annual Report for 2010-2011. Review the list of Activations (SM-3) and Proposals (SM-4) for 2010-2011 to determine whether external funding has been increased. This review can also be used to determine whether one new funding source was obtained.

## SUPPORTING MATERIALS

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**Early TCA Experiments with Self-Compacting Pervious PCC**  
(Photo courtesy of Dr. L.K. Crouch)



**CESR FACULTY AND STAFF 2009-2010**

<b>Center Director:</b>	Dr. Sastry Munukutla	Director and Professor, ME
<b>Core Faculty:</b>	Dr. (David) Wenzhong Gao	Assist. Professor, ECE
<b>CESR Staff:</b>	Dr. Vijayasekaran Boovaragavan	Research Asst. Professor, ChE
	Dr. James Beard	Research Associate
	Robert Craven	R&D Engineer
	Anthony Greenway	Network Manager
	Dr. Ganesh B. Kumbhar	Post Doctoral Assistant
	Dr. James C. Pirkle, Jr.	R&D Engineer II
	Dr. Shaobu Wang	Post Doctoral Assistant
	Meharegzi Tewolde Abreham	Research Assistant I
	Etter Staggs	Financial Analyst
	Sandra Garrison	Grants Fiscal Clerk
	Linda Lee	Secretary III



In addition to center faculty, the following faculty members participated in center activities during 2009-2010. Faculty involvement included conducting externally or internally funded research, preparing and presenting high quality research papers, preparing and marketing proposals, directing graduate students, and improving instructional courses and laboratories.

## **BASIC ENGINEERING**

Ken Hunter

## **CHEMICAL ENGINEERING**

Pedro Arce, **Chairperson**  
Joseph Biernacki  
Mario Oyanader  
Holly Stretz  
Venkat Subramanian

## **ELECTRICAL & COMPUTER ENGINEERING**

Stephen Parke, **Chairperson**  
Mohamed Abdelrahman  
Ali Alouani  
Omar Elkeelany  
Satish Mahajan  
Joseph Ojo  
Ghadir Radman

## **CIVIL & ENVIRONMENTAL ENGINEERING**

Xiaoming (Sharon) Huo, **Interim Chairperson**  
Daniel A. Badoe  
Steven Click  
Lewis K. Crouch  
R. Craig Henderson  
Y. Jane Liu  
Benjamin Mohr  
Guillermo Ramirez  
Lenly J. Weathers

## **MECHANICAL ENGINEERING**

Darrell E. P. Hoy, **Chairperson**  
Stephen Canfield  
Jie Cui  
Glenn Cunningham  
Corinne M. Darvennes  
Stephen A. Idem  
Mahesh Panchagnula  
John Peddieson

## **ENGINEERING ADMINISTRATION TECHNOLOGY**

Dr. David Huddleston, **Interim Dean**  
Subramaniam Deivanayagam,  
Associate Dean for Graduate  
Studies and Research

## **MANUFACTURING & INDUSTRIAL**

Ahmed H. ElSawy, **Chairperson**  
Ismail Fidan  
Ahmed Kamal

## **COMPUTER SCIENCE**

Ambareen Siraj  
Sheikh Ghafoor

## **CURRICULUM AND INSTRUCTION**

Holly Anthony

## **MATHEMATICS**

Sabine LeBorne  
Sam Narimetla  
Alexander Shibakov





# FACULTY EXPERTISE

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## CHEMICAL ENGINEERING

**Pedro Arce:** Electrokinetics-Soil Clean up – High Oxidation Cold Plasma Methods-Water Pollution Control – Gel Electrophoresis – Drug Delivery Materials – Modeling of Transport Process in Porous Media with Reactions

**Joe Biernacki:** Cement-based Materials – Micro-fluidics – Ceramic Materials – Electron Ceramics - Microelectromechanical Systems

**Holly Stretz:** Polymer processing – Surfactants – Composite Modeling – Nanoparticle Deposition – High temperature Composite Stability – Biodiesel Reaction Kinetics – Nanocomposites - Ablation

## CIVIL AND ENVIRONMENTAL ENGINEERING

**Daniel Badoe:** Transportation Demand Analysis – Transferability of Demand Models – Transport Systems Analysis – Discrete Choice Models Applied to Travel Demand – Travel Surveys

**George Buchanan:** Finite Element Analysis – Solid Mechanics – Structural Analysis – Vibrations

**Steven Click:** Traffic signal operations – Traffic signal system operations – Urban arterial operations – Traffic signal controller functions – Traffic signal master controller functions – Non-traditional intersection and arterial designs

**L.K. Crouch:** Aggregates – Portland Cement Concrete – Controlled Low-strength Materials – Hot-mix Asphalt – Construction Materials Testing

**R. Craig Henderson:** Masonry Design – Seismic Design – Earthquake Engineering – Structural Codes – Infilled Frames

**X. Sharon Huo:** Structural Analysis – Prestressed Concrete Analysis and Design – Bridge Analysis and Design – Reinforced Concrete Analysis and Design – Structural Steel Analysis and Design

**Y. Jane Liu:** Applied Mechanics – Finite Element Analysis – Advanced Computational Mechanics – Composite Materials – Plates and Shells Analysis

**Benjamin Mohr:** Durability, microstructure, and chemistry of cement-based materials – Early-age behavior of cement and concrete – Fiber-reinforced concrete – Supplementary cementitious materials

**Guillermo Ramirez:** Computational and Theoretical Mechanics – Laminated Plates and Shells – Piezo and Magneto Elastic Solids – Smart Structures

# FACULTY EXPERTISE

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## ELECTRICAL AND COMPUTER ENGINEERING

**Mohamed Abdelrahman:** Sensor Fusion – Wireless Sensors – Intelligent Control – Integration of Sensing and Control – Instrumentation

**Ali Alouani:** Signal Processing and Control – Fuzzy Logic – Power Systems – Complex Systems – Sensor Data Fusion

**Satish Mahajan:** Lasers – LEDs – Solar Cells – Optical Fibers – High Power Switchgear

**Joseph Ojo:** Electric Machine Analysis and Design – Adjustable-Speed Motor Drives – Power Electronic Converters – Control Theory Applied to Power Electronics and Power Systems – Power Systems Economics and Deregulation Issues

**Ghadir Radman:** Modeling / Simulation of Power Systems – Dynamics / Transient Stability in Power Systems – Flexible AC Power Transmission (FACTS) – Power Flow / Optimal Power Flow – Reactive Power Compensation and Voltage Stability

**P.K. Rajan:** Circuits and Signals – Digital Signal Processing – Independent Component Analysis – Digital Image Processing, Pattern Recognition

**Arun Sekar:** Power Systems – Electrical Machines – Power Electronics

## MECHANICAL ENGINEERING

**Steve Canfield:** Robotics – Dynamic Modeling – Compliant Mechanisms – Smart Actuators – Mechatronics

**Jie Cui:** Computational Fluid Dynamics – Turbulence Modeling – Large Eddy Simulation – Numerical Heat Transfer – Thermal Fluids

**Glenn Cunningham:** Remaining Life Analysis – Fatigue, Creep and Fracture Analysis – Thermal Sciences – Energy Conservation and Management – Heating, Ventilation, and Air Conditioning (HVAC)

**Corrine Darvennes:** Acoustics – Noise Control – Ultrasonics – Nondestructive Evaluation

**Stephen Idem:** Scale Model Testing – Fluid Flow Measurement – Thermal Modeling – Fluid Mechanics– Heat Transfer

**Mahesh Panchagnula:** Nanoscale Fluid Mechanics – Combustion – Liquid Atomization

**John Peddieson:** Multiphase Flow – Friction Stir Welding – Tether Dynamics – Fluid Mechanics – Solid Mechanics

# FACULTY EXPERTISE

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## MANUFACTURING AND INDUSTRIAL TECHNOLOGY

**Ahmed ElSawy:** Development of Manufacturing Processes – Welding Engineering and Metallurgy – Recycling and Reuse of Industrial Solid Waste Materials – Web-based Distance Learning – Computer Applications in Technology

**Ismail Fidan:** Manufacturing Processes – Electronics Manufacturing – Knowledge-based Systems – Web-based Distance Learning – Rapid Prototyping

**Ahmed Kamal:** Embedded Control System – Sensor and Biosensor – Digital Signal Processing – Biomedical System – System Identification

## MATHEMATICS

**Sabine Le Borne:** Computational Fluid Dynamics – Multi-Grid Methods – Hierarchical Matrices



# CONTRACT AND GRANT AWARDS

SM-3

Activated Between July 1, 2009 and June 30, 2010

## POWER SYSTEMS PERFORMANCE IMPROVEMENT

Contract Number	Title	Source	Project Dates	Total Amount	Estimated Expendit.
531652	Career: Wind Power	NSF - ARRA	9/1/09-8/31/10	80,000	11,393
539334	Smart Grid Research	ORNL - DOE	9/28/09-12/31/10	415,000	201,237
532344	Multi-Phase Induction	ONR	7/1/08-6/30/10	76,322	230,101
532344	Multi-Phase Induction	ONR	7/1/08-6/30/11	105,668	0
<b>SUB - TOTAL</b>				<b>676,990</b>	
<b>POWER SYSTEMS PERFORMANCE IMPROVEMENT</b>					<b>442,731</b>

## ENVIRONMENTAL ISSUES AND ENERGY CONSERVATION

Contract Number	Title	Source	Project Dates	Total Amount	Estimated Expendit.
531255	Travel to VPPC 09	National Science Foundation	9/1/09-2/28/10	5,800	5,700
531641	Wind Energy Integration	Department of Energy (ARRA)	11/1/09-10/31/10	131,309	15,062
<b>SUB - TOTAL</b>					
<b>ENVIRONMENTAL ISSUES AND ENERGY CONSERVATION</b>				<b>137,109</b>	<b>20,762</b>

**CONTRACT AND GRANT AWARDS****SM-3****ADVANCED TECHNOLOGIES**

Contract Number	Title	Source	Project Dates	Total Amount	Estimated Expendit.
538233	Laboratory Testing of Saddle Tap Tees	Spiral Duct Manufacturers Association (SPIDA)	7/1/09-3/30/10	22,440	21,412
536229	Modeling of Moisture Diffusion	United Launch Alliance (ULA)	4/1/09-12/1/09	45,000	44,999
531651	Saddle Point Problems	NSF ARRA	7/1/09-6/30/10	34,295	29,966
539510	EIME Preschool Age	Tennessee Department of Education	7/1/09-6/30/10	28,000	24,406
539511	EIME School Age	Tennessee Department of Education	7/1/09-6/30/10	7,000	5,974
536350	Air Blast Atomization	Goodrich Corporation	8/18/09-7/17/10	44,800	36,082
539273	Kingston Ash - Federal	TDOT	9/15/09-9/14/10	48,000	1,086
533215	Kingston Ash - State	TDOT	9/15/09-9/14/10	12,000	271
539277	Optimum Air Content - State	TDOT	9/15/09-9/14/10	12,000	3,911
539274	Optimum Air Content - Federal	TDOT	9/15/09-9/14/10	48,000	26,000
539275	Tennessee Bridge Design - Federal	TDOT	9/15/09-9/14/10	26,000	4,707
539276	Tennessee Bridge Design - State	TDOT	9/15/09-9/14/10	6,500	2,940
539278	Traffic Signal - Federal	TDOT	1/1/10-12/31/10	53,600	649
533216	Traffic Signal - State	TDOT	1/1/10-12/31/10	13,400	2,969
536229	Moisture Diffusion	ULA	5/1/09-10/15/10	8,000	0
535244	Wire Core Transformer	Buswell Energy	5/24/10-12/31/10	74,999	0
<b>SUB - TOTAL</b>				<b>484,034</b>	
<b>ADVANCED TECHNOLOGIES</b>					<b>205,372</b>

**POWER-TEST-SERVICE ACCOUNT**

Contract Number	Title	Source	Project Dates	Total Amount	Estimated Expendit.
538597	Power-Test-Service Account				
	Testing Services -- Gallatin Steam Plant	TVA Gallatin Steam Plant	6/1/08-8/24/09	2,619	2,619
	Laboratory Testing to Determine Thermal Effectiveness of Combinations of Thermal Plastics and High Efficiency Insulation Materials	Manufacturing Project Management	1/4/10-5/7/10	2,500	2,500
	ECE PCC Cylinder Testing	ECE Services	5/1/09-8/31/09	190	190
	ECE PCC Cylinder Testing	ECE Services	8/1/09-12/31/09	1,980	1,980
	Can Crushing Strength Testing	American Manufacturing and Packaging	8/1/09-12/31/09	150	150
	ECE PCC Cylinder Testing	ECE Services	1/2/09-5/10/09	2,085	2,085
	No Compaction Pervious PCC Testing	Tennessee Concrete Association	1/2/09-5/10/09	4,500	4,500
	Pervious PCC Testing for Concrete	Tennessee Concrete Association	2/15/10-4/10/10	400	41
	ASTM C 1688 Pervious PCC Testing	Tennessee Concrete Association	1/15/10-4/12/10	1,250	0
	ECE PCC Cylinder Testing	ECE Services	1/4/10-3/8/10	240	0
	High Strength PCC Testing	Moyer's Metal Sales	3/31/10-4/26/10	130	0
	<b>SUB - TOTAL</b>			<b>16,044</b>	<b>14,065</b>
	<b>POWER-TEST-SERVICE ACCOUNT</b>				



# CONTRACT AND GRANT AWARDS

SM-3

## MISCELLANEOUS

Contract Number	Title	Source	Project Dates	Total Amount	Estimated Expendit.
531692	ARRA Energy Center	American Recovery and Reinvestment Act	7/1/09-6/30/10	48,300	48,300
----	Award for Excellence in Electric Power	Various Sources	7/1/09-6/30/10	4,500	4,500
----	TVA Upperclassman Scholarship Award	Tennessee Valley Authority	7/1/09-6/30/10	1,500	1,500
229342	TTU Research	TTU	7/1/09-6/30/10	12,550	12,550
229638	IC Faculty Energy Systems Gao	TTU	7/1/09-6/30/10	5,540	566
229660	IC Faculty Energy Systems Munukutla	TTU	7/1/09-6/30/10	2,640	0
229691	IC Faculty Energy Systems Beard	TTU	7/1/09-6/30/10	1,490	1,490
229732	IC Faculty Energy Systems Craven	TTU	7/1/09-6/30/10	180	180
<b>SUB - TOTAL MISCELLANEOUS</b>				<b>76,700</b>	<b>69,086</b>
<b>TOTAL CONTRACTS AND GRANTS: 2009 - 2010</b>				<b>1,390,877</b>	<b>752,016</b>

**Submitted Between July 1, 2009 and June 30, 2010**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
1.	Supplement to Transport Kinetics of Internal Curing Water in High Performance Concretes	Dr. Benjamin Mohr	National Science Foundation	9,765	Unfunded
2.	CAREER: Nanoscale Characterization of Expansion Due to Delayed Ettringite Formation	Dr. Benjamin Mohr	National Science Foundation	400,002	Unfunded
3.	CAREER: Dynamical Interaction of Sessile Drops with Multiscale Surface Heterogeneities	Dr. Mahesh Panchagnula	National Science Foundation	468,256	Unfunded
4.	CAREER: Nanoparticle Barrier Layers: Strengthening the Network	Dr. Holly Stretz	National Science Foundation	439,104	Unfunded
5.	CAREER: Wind Power -- Multi-Level Control, Intelligent Grid Integration and Real Time Digital Simulation	Dr. Wenzhong Gao	National Science Foundation	400,000	Funded
6.	National Wind Energy Consortium	Dr. Wenzhong Gao, Dr. Sastry Munukutla, Dr. Ghadir Radman, Dr. Jie Cui	U. S. Department of Energy (ARRA)	12,000,000	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2009-2010</b>				<b>13,717,127</b>	

**Submitted Between July 1, 2009 and June 30, 2010**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
7.	MRI-R2: Acquisition of Nanoindenter for Characterization of Advanced High Performance Materials	Dr. Benjamin Mohr, L. K. Crouch	Dr. National Science Foundation	534,136	Unfunded
8.	Preliminary Investigation of Beneficial Uses of Kingston Ash Material	Dr. L. K. Crouch, Dr. Lenly Weathers, Dr. Daniel Badoe	Tennessee Department of Transportation	105,000	Funded
9.	Risk Assessment and Optimization of Power Grid Operation with Variable Renewable Generation	Dr. Wenzhong Gao	U. S. Department of Energy	1,164,380	Unfunded
10.	Field Evaluation of Traffic Signal Based Interchange Treatments	Dr. Steven Click	Tennessee Department of Transportation	200,000	Funded
11.	Simplified Live Load Distribution Factor Equations for Tennessee Highway Bridge Design	Dr. Xiaoming Sharon Huo	Tennessee Department of Transportation	65,000	Funded
12.	GOALI: A Unified Multiphase Transport Model of Spray Atomization, Evaporation and Combustion	Dr. Mahesh Panchagnula, Dr. Jie Cui, Dr. John Peddieson	National Science Foundation	299,967	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2009-2010</b>				<b>2,368,483</b>	

**Submitted Between July 1, 2009 and June 30, 2010**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
13.	GOALI: Development and Application of a General Elastic Stability Theory Accounting for Initial Imperfections	Dr. Jane Liu, Dr. John Peddieson	National Science Foundation	299,967	Unfunded
14.	Water Current Turbine Power Generation for the Grid	Dr. Joseph Ojo	National Science Foundation	326,333	Unfunded
15.	Optimum Air Content Range (Plastic and Hardened) for TDOT Class D PCC	Dr. L. K. Crouch, Dr. Benjamin Mohr, Dr. Daniel Badoe, Dr. Jane Liu	Tennessee Department of Transportation	130,000	Funded
16.	Enhancing the Programming Experience for Engineering Students through Hands-On Integrated Computer Experiences: Phase II Proposal	Dr. Stephen Canfield, Dr. Mohamed Abdelrahman, Dr. Sheikh Ghafoor, Dr. Holly Anthony, Dr. David Smith	National Science Foundation	600,000	Pending
17.	Collaborative Education Research: Transforming iTECH to eCE Through Agent-Based Network System for STEM Learning Environment	Dr. Ismail Fidan, Dr. Holly Anthony	National Science Foundation	400,000	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2009-2010</b>				<b>1,756,300</b>	

**Submitted Between July 1, 2009 and June 30, 2010**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
18.	REU Site: Design and Development of Medical Diagnosis Support Systems	Dr. Ahmed Kamal, Dr. Ali T. Alouani, Dr. Omar Elkeelany	National Science Foundation	329,829	Unfunded
19.	Enabling Families, Infants, and Toddlers Through Technology: Merging Early Intervention and Mechanical Engineering (EIME)	Dr. Stephen Canfield, Mr. Ken Hunter	Tennessee State Department of Education -- Division of Special Education	35,000	Funded
20.	High Performance Computing Based Numerical Modeling of Friction Stir Welding	Dr. Jie Cui	Oak Ridge Associated Universities Partnerships Office	75,000	Unfunded
21.	Modeling of Moisture Diffusion in Composites	Dr. John Peddieson, Dr. Jane Liu	United Launch Alliance	8,000	Funded
22.	Advanced Systems Development of the MRWS: a Remote Climbing Robot for Automating Welding Processes in the Ship Building Industry	Dr. Ahmed Elsayy	National Shipbuilding Research Program (NSRP) (A subcontract through Advanced Technologies Institute)	24,011	Funded
23.	High Volume Fly Ash PCC for Sustainability and Performance	Dr. L. K. Crouch, Dr. Ben Mohr, Dr. Daniel Badoe	Tennessee Department of Transportation	130,000	To be funded
<b>SUBTOTAL, PROPOSALS FOR 2009-2010</b>				<b>601,840</b>	

**Submitted Between July 1, 2009 and June 30, 2010**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
24.	Validation of a Low-Order Acoustic Model of Boilers and its Application for Diagnosing Combustion Driven Oscillations	Dr. John Peddieson, Dr. Stephen Idem	ASHRAE, Inc.	119,743	Unfunded
25.	Innovation in Teaching Industrial Electronics Course	Dr. Ahmed Kamal	National Science Foundation	189,180	Pending
26.	Decentralized Intelligent Architecture for Distribution-Grid Health Management	Dr. Ali Alouani, Dr. Satish Mahajan, Dr. Ghadir Radman, Dr. Omar Elkeelany, Dr. Ambareen Siraj	U. S. Department of Energy	1,137,076	Pending
27.	Development of a Wire Core Transformer	Dr. Satish Mahajan	Buswell Energy, LLC	74,999	Funded
28.	Smart Grid Research	Dr. Sastry Munukutla, Dr. Wenzhong Gao, Dr. Joseph Ojo, Dr. Ghadir Radman, Dr. Omar Elkeelany, Dr. John Peddieson, Dr. Jie Cui, Dr. Ambareen Siraj, Mr. Robert Craven	Oak Ridge National Laboratory (Department of Energy)	415,000	Funded
29.	Nanoscale Characterization of Expansion Due to Delayed Ettringite Formation	Dr. Benjamin Mohr	National Science Foundation	340,472	Funded at \$299,943
<b>SUBTOTAL, PROPOSALS FOR 2009-2010</b>				<b>2,276,470</b>	
<b>TOTAL, PROPOSALS FOR 2009-2010</b>				<b>20,720,220</b>	

**Submitted Between July 1, 2008 and June 30, 2009**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
1.	Wind Power -- Multi-Level Control, Intelligent Grid Integration and Real Time Digital Simulation	Wenzhong David Gao	National Science Foundation	400,000	Activated in 2009-2010
2.	Development and Demonstration of a Mobile Robotic Ship Welding System	Stephen Canfield, Ahmed Elsayy	Robotic Technologies of Tennessee (RTT)	151,961	Activated at \$151,962
3	The Development of a Remotely Accessible Rapid Prototyping Laboratory (Addendum)	Ismail Fidan	National Science Foundation	20,228	Activated at \$17,600
4.	12kW Photovoltaic Solar Power Distributed Generation at TTU	Wenzhong David Gao, Larry Wheaton	Tennessee Valley Authority	5,000	Activated
5.	Numerical Modeling of Friction Stir Welding	Jie Cui	ORAU Partnership Development Office	75,000	Unfunded
6.	Life Modeling of Li-ion Cells	Venkat Subramanian	U. S. Government	682,000	Activated
7.	GOALI: An Advanced General Theory of Elastic Stability with Application to Imperfect Cylindrical Sandwich Shells	Jane Liu, John Peddieson	National Science Foundation	299,967	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2008-2009</b>				<b>1,634,156</b>	

**Submitted Between July 1, 2008 and June 30, 2009**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
8.	Enabling Children with Disabilities and Their Families in Tennessee through Technology EIME Project	Stephen L. Canfield, Kenneth Hunter	State Department of Education -- Division of Special Education	35,000	Activated in 2009-2010
9.	Utilization of Spray Dryer Absorber Materials in High Volume Applications	Joseph Biernacki	Tennessee Valley Authority	45,566	Unfunded
10.	Algebraic Hierarchical Matrix Preconditioners for Two- and Three-Dimensional Saddle Point Problems	Sabine LeBorne	National Science Foundation	137,149	Activated in 2009-2010
11.	Validation of Low-Order Acoustic Model of Boilers and Its Application for Diagnosing Combustion Driven Oscillations (TRP-1517)	John Peddieson, Mahesh Panchagnula, Stephen Idem, Robert Craven	ASHRAE, Inc.	115,546	Unfunded
12.	CCLI Phase III: A National Model for Education in E-Quality Integrated with Web-enabled Manufacturing and Management (EQMM)	Ismail Fidan, Holly Anthony	National Science Foundation	270,000	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2008-2009</b>				<b>603,261</b>	



**Submitted Between July 1, 2008 and June 30, 2009**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
13.	Design and Development of an Integrated Multipurpose Medical Diagnostic Support System	Ali Alouani, Omar Elkeelany, Ahmed Kamal	National Institutes of Health	523,125	Unfunded
14.	REU: Collaborative Research: Model Reformulation for Lithium-ion Batteries-- Parameter Estimation and Dynamic Optimization	Venkat Subramanian	National Science Foundation (CBET)	6,000	Activated
15.	Modeling Air Blast Atomization	Mahesh Panchagnula, John Peddieson, Robert Craven	Goodrich Turbine Fuel Technologies	178,579	Funded at \$44,800 in 2009-2010
16.	Development of High Altitude Simulator	Mahesh Panchagnula, David Walker, Robert Craven	Goodrich Aerospace	29,585	Unfunded
17.	Collaborative Research: Optimal Design of Electrode Materials for Electrochemical Energy Storage	Venkat Subramanian	National Science Foundation	275,314	Unfunded
18.	Mobility of Internal Curing Water in Blended Cementitious Systems	Benjamin Mohr	National Science Foundation	265,570	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2008-2009</b>				<b>1,278,173</b>	

**Submitted Between July 1, 2008 and June 30, 2009**

	<b>TITLE</b>	<b>INVESTIGATORS</b>	<b>SOURCE</b>	<b>AMOUNT</b>	<b>STATUS</b>
19.	Multi-Level Energy Storage and Controls for Large-Scale Wind Energy Integration	Wenzhong David Gao	Department of Energy	265,677	Activated in 2009-2010
20.	Development of Li-ion Battery Tool for Predicting Life and Performance for Satellite Orbit Operation Scenarios	Venkat Subramanian	Global Aerospace Corporation	30,000	Activated
21.	Modeling of Moisture Diffusion in Composites	Jane Liu, John Peddieson	United Launch Alliance	30,000	Activated in 2009-2010
22.	Intergovernmental Personnel Act Agreement (#6)	Guillermo Ramirez	Naval Postgraduate School	18,000	Activated
23.	Modeling Surface Topography Contribution to Ablative Performance of Nanocomposites	Holly Stretz, Mahesh Panchagnula, Sastry Munukutla	Air Force Office of Scientific Research (AFOSR)	598,109	Unfunded
24.	Inlet and Discharge Installation Effects on Airfoil (AF) Centrifugal Plenum/Plug Fans for Air and Sound Performance	Stephen Idem, Corrine Darvennes	The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)	109,068	Unfunded
<b>SUBTOTAL, PROPOSALS FOR 2008-2009</b>				<b>1,050,854</b>	

## STATUS OF PROPOSALS

SM-5

Submitted Between July 1, 2008 and June 30, 2009

	TITLE	INVESTIGATORS	SOURCE	AMOUNT	STATUS
25.	Teaching Industrial Electronics for Innovation	Ahmed Kamal	National Science Foundation (CCLI)	177,720	Unfunded
26.	Enhancing Access to Power and Renewable Energy Engineering Education through a K-12, Community College and University Laboratory Network	Arun Sekar, Wenzhong David Gao, Joseph Ojo, Stephen Parke	National Science Foundation (CCLI)	249,197	Unfunded
27.	Laboratory Testing of Increased Area (Pressed) Saddle Tap Tees to Determine Loss Coefficients	Dr. Stephen Idem	Spiral Duct Manufacturers Association (SPIDA)	22,440	Activated in 2009-2010
28.	FNET Tools Development	Dr. Wenzhong David Gao	Tennessee Valley Authority	29,874	Activated
29.	NSF Travel Support for Students Attending the 5th IEEE Vehicular Power and Propulsion Conference (VPPC 2009)	Dr. Wenzhong David Gao	National Science Foundation	5,800	Activated in 2009-2010
30.	Power-Test-Service Account	Dr. Sastry Munukutla, Dr. L. K. Crouch, Dr. Stephen Idem, Dr. James Beard	Various Sources	37,062	Activated
<b>SUBTOTAL, PROPOSALS FOR 2008-2009</b>				<b>522,093</b>	
<b>TOTAL, PROPOSALS FOR 2008-2009</b>				<b>5,088,537</b>	

**Daniel Augustus Badoe**

Mwakalongo, J. and Badoe, D.A. (2010). Comparison of forecast performance of alternative methods for estimating trip rates of cells of cross-classification matrix with inadequate data. Proceedings of the 89<sup>th</sup> Annual Transportation Research Board Conference, Washington D.C

Ivey, S.S. and Badoe, D.A. (2010). A Survey of Policies on Access to Transportation Planning Data, Models, and Cost Recovery. Proceedings of the 89<sup>th</sup> Annual Transportation Research Board Conference, Washington D.C

Badoe, D. A. (2009), Synthesizing Reliable Trip-Rates for Cross-Classification Cells with Inadequate Data in Trip Generation Modeling. Final Research Report submitted to the Faculty Research Committee, Tennessee Technological University (October 2009)

**Stephen Canfield**

Canfield, S. L., Peddieson, J, and G. Garbe, "Similarity Rules for Scaling Solar Sail Systems," submitted to *AIAA Journal of Spacecraft and Rockets*, 2010.

Canfield, S. L., and A. Otoole, "Introducing Autonomous Manufacturing Devices into the Shipbuilding Industry," submitted to *International Journal of Agile Manufacturing*, January, 2010.

Canfield, S. L, Shibakov, A., and J. Richardson, "Design Space Analysis of Distributed Compliance in Segmented Beam Templates of Compliant Mechanisms," submitted to the *ASME Journal of Mechanical Design*, Aug. 2009.

Canfield, S. L., and M. A. Abdelrahman, "Redesign and Evaluation of a Programming Experience for Engineering Students through Hands-On Integrated Computer Experiences," submitted to *ACM Transactions on Computing Education*, January, 2010.

Canfield, S. L, Shibakov, A., and J. Richardson, "Design Space Analysis of Distributed Compliance in Segmented Beam Templates of Compliant Mechanisms," *Proc. of the 2009 ASME International Design Engineering Technical Conferences*, San Diego, CA, Aug. 30 – Sept 1, 2009, DETC2009-87246.

**L.K. Crouch**

"Early TCA Experiments with Self-Compacting Pervious PCC", L. K. Crouch, Marcus L. Knight and Alan Sparkman, *Tennessee Concrete*, Vol. 23, No. 3, Winter 2009.

**Cunningham, Glenn**

"Industrial Assessment Center Report for Federal Mogul," Sparta, TN, January, 2010

"Industrial Assessment Center Report for Unipres," Portland, TN, January, 2010

"Industrial Assessment Center Report for Jeld-Wen," Sparta, TN, October, 2009

"Industrial Assessment Center Report for Franklin Industrial Minerals," Crossville, TN, August, 2009

"Industrial Assessment Center Report for Rich Products," Murfreesboro, TN, August, 2009

**Cui, Jie**

"Comparison of Turbulence Models in Simulating Swirling Pipe Flows," with A. Escue, *Applied Mathematical Modeling*, DOI:10.1016/j.apm.2009.12.018, 2010

"Performance of Turbulence Models for Flow through Rough Pipes," with S. Vijiapurapu, *Applied Mathematical Modeling*, Vol. 34, pp. 1458-1466, DOI:10.1016/j.apm.2009.08.029, 2010

"Numerical Study of Turbulent Flows through a Circular Duct with a Rotating Fan," with G. Rajwade, paper IMECE2009-11269, ASME International Mechanical Engineering Congress and Exposition, Lake Buena Vista, Florida, November 13-19, 2009

"Numerical Modeling of Pressure Losses Caused by Bends in Pneumatic Conveying Pipeline," paper IMECE2009-11676, ASME International Mechanical Engineering Congress and Exposition, Lake Buena Vista, Florida, November 13-19, 2009

**Elkeekany, Omar**

Ali Alouani, Omar Elkeelany, and Mohammed Abdallah, "Stand-alone Portable Digital Body Sound Data Acquisition Device," *International Journal of Embedded Systems*, (IJES) 2009.

O. Elkeelany, "On Chip Novel Video Streaming System for Bi-network Multicasting Protocols," *Integration, the VLSI journal*, vol. 42, pp. 356-366, DOI: 10.1016/j.vlsi.2008.10.001, 2009.

**Gao, (David) Wenzhong**

A. V. Kulkarni, Wenzhong Gao, and J. Ning, "Study of Power System Load Shedding Scheme Based On Dynamic Simulation," *IEEE Transmission and Distribution Conference and Exposition (IEEE T & D)*, New Orleans, April 19-22, 2010.

S. Nasser Keshmiri and Wenzhong Gao, "Transmission Loss Allocation Using Normalized Loss Weight Factors in Bilateral Contracts Environment," *41th North American Power Symposium (NAPS)*, Starkville, Mississippi, September, 2009.

Vadim Zheglov, Wenzhong Gao, O. Ojo, "New Control of Two Three-Phase Induction Machines Using an Integrated Inverter for Applications in Hybrid Electric Vehicles," *NAPS 2009*.

Jiaxin Ning, Wenzhong Gao, G. Radman, J. Liu, "The Application of the Groebner Basis Technique in Power Flow Study," *NAPS 2009*.

Andrew Watkins, Wenzhong Gao, "An Experimental Environment for Studying Hybrid Fuel Cell System Operating Characteristics," *NAPS 2009*.

Agustin Melero Perez and Wenzhong Gao, "Fuzzy Logic Energy Management Strategy for Fuel Cell/Ultracapacitor/Battery Hybrid Vehicle with Multiple-Input DC/DC Converter," the 5<sup>th</sup> *IEEE Vehicular Power and Propulsion Conference*, September 7-11, 2009, Dearborn, MI 48128.

Jiaxin Ning and Wenzhong Gao, "Continuous Wavelet-Based Active Filter Design for Harmonic Mitigation in Hybrid Electric Vehicles," the 5<sup>th</sup> *IEEE Vehicular Power and Propulsion Conference*, September 7-11, 2009, Dearborn, MI 48128.

Sharanya Jaganathan and Wenzhong Gao, "Battery Charging Power Electronics Converter and Control for Plug-in Hybrid Electric Vehicle," the 5<sup>th</sup> *IEEE Vehicular Power and Propulsion Conference*, September 7-11, 2009, Dearborn, MI 48128.

Vadim Zheglov and Wenzhong Gao, "Double Input DC/DC Converter topology for Hybrid Electrical Vehicles," the 5<sup>th</sup> *IEEE Vehicular Power and Propulsion Conference*, September 7-11, 2009, Dearborn, MI 48128.

Jianfu Fu, David Gao and Liwei Song, "Principal Component Analysis Based on Drive Cycles For Hybrid Electric Vehicle," *5th IEEE Vehicular Power and Propulsion Conference*, September 7-11, 2009, Dearborn, MI 48128.

Vadim Zheglov, Wenzhong Gao, Eduard Muljadi, and Ge Wang, "New Control Strategy for Stand-alone Fuel Cell-battery Hybrid Power Supply System," *IEEE PES General Meeting*, Calgary, Canada, July, 2009.

Jiaxin Ning and Wenzhong Gao, "A Wavelet-based Method to Extract Frequency Feature for Power System Fault/Event Analysis," *IEEE PES General Meeting*, Calgary, Canada, July, 2009.

Ranjan Behera and Wenzhong Gao, "Low Voltage Ride-through and Performance Improvement of a Grid Connected DFIG System," *3rd International Conference on Power Systems (ICPS-2009)*, Dec. 27-29, 2009, IIT Kharagpur.

**Idem, Stephen**

Gibbs, D.C. and Idem, S., 2010, "Measured and Predicted Pressure Loss in Corrugated Spiral Duct," *ASHRAE Transactions*, Accepted for Publication.

Gibbs, D.C. and Idem, S., 2010, "Measurements of Flat Oval Diverging Flow Fitting Loss Coefficients," *ASHRAE Transactions*, Accepted for Publication.

Gibbs, D.C. and Idem, S., 2010, "Flat Oval Duct Leakage Class Measurement," *ASHRAE Transactions*, Accepted for Publication.

**Idem, Stephen (Continued)**

Khaire, S. and Idem, S., 2010, "Influence of Test Section Entrance Conditions on Straight Flat Oval Duct Apparent Relative Roughness," *ASHRAE Transactions*, Accepted for Publication.

Darvennes, C. Young, M.N., and Idem, S., 2009, "Acoustic System Effects of Propeller Fans Due to Inlet Installations," *ASHRAE Transactions*, Vol. 115, Part 1, pp. 48-57.

Young, M.N., Darvennes, C., and Idem, S., 2009, "Test Apparatus and Procedure to Measure Inlet Installation Effects of Propeller Fans," *ASHRAE Transactions*, Vol. 115, Part 2, pp. 432-441.

Kulkarni, D., Khaire, S. and Idem, S., 2009, "Influence of Aspect Ratio and Hydraulic Diameter on Flat Oval Elbow Loss Coefficients," *ASHRAE Transactions*, Vol. 115, Part 1, pp. 48-57.

Kulkarni, D., Khaire, S., and Idem, S., 2009, "Measurements of Flat Oval Elbow Loss Coefficients," *ASHRAE Transactions*, Vol. 115, Part 1, pp. 35-47.

Kulkarni, D., Khaire, S., and Idem, S., 2009, "Pressure Loss of Corrugated Spiral Duct," *ASHRAE Transactions*, Vol. 115, Part 1, pp. 28-34.

**Le Borne, Sabine**

S. Le Borne, Che Ngufor, An implicit approximate inverse preconditioner for saddle point problems. ETNA, to appear (2010)

S. Le Borne, Preconditioned nullspace method for the two-dimensional Oseen problem. *SIAM J. Sci. Comp.* 31, 2494-2509 (2009)

**Mohr, Benjamin**

Mohr, B.J., Hood, K.L. "Influence of Bleed Water Reabsorption on Cement Paste Autogenous Deformation." *Cement and Concrete Research*, 2010; 40(2):220-225.

Ojo, J.O., Mohr, B.J. "A Review of the Analysis of Cement Hydration Kinetics via <sup>1</sup>H Nuclear Magnetic Resonance." In: *Proceedings of the 3rd International Symposium on Nanotechnology in Construction (NICOM3)*, Prague, Czech Republic, May 31-June 2, 2009, Eds. Bittnar, Z., Bartos, P.J.M., Nemecek, J., Smilauer, V., Zeman, J., 2009: 107-112.

Mohr, B.J., Hood, K.L., Kurtis, K.E. "Mitigation of Alkali-Silica Expansion in Pulp Fiber Mortar Composites." *Cement and Concrete Composites*, 2009; 31(9):677-681.

Mohr, B.J., Biernacki, J.J., Kurtis, K.E. "Supplementary Cementitious Materials for Mitigating Kraft Pulp Fiber-Cement Composite Degradation." *Cement and Concrete Research*, 2007;37(11): 1531-1543.

**Munukutla, Sastry**

"Performance Monitoring of Coal-Fired Units in Real-Time" (with R. Craven and M.R. Coffey) *ASME Power 2009*, July 21 – 23, 2009, Albuquerque, New Mexico

"Evaluation of Plant Operation Using Real-Time Performance Monitoring", *Power-Gen Asia 2009 Conference*, October 7–9, 2009, Bangkok, Thailand

"Software for Inexpensive On-Line Monitoring of Efficiency and Greenhouse Gas Emissions in Coal-Fired Units", (with R. Craven) paper presented at *PowerGen-India Conference*, April 21-23, 2010, Mumbai, India.

"Simulation of Particle/Fluid Flows in Vertical Circular Pipes", (with R. You, J. Peddieson and J. Gadiyaram), *International Journal of Non-Linear Mechanics*, 45 (2010) pp. 490-506

**Panchagnula, Mahesh**

B.R. Prabhala, M.V. Panchagnula, V. Subramanian and S. Vedantam, "A simple analytical solution for the shape of a non-axisymmetric sessile drop", 2010, (revision requested) *Langmuir*

P.S. Bhosale and M.V. Panchagnula, "Phase inversion in evaporating polyelectrolyte liquid marbles", 2010, (revision requested) *Langmuir*

N.P. Rayapati, M.V. Panchagnula, J. Peddieson, J.D. Short and S.P. Smith, "Eulerian multiphase population balance model of fragmentation processes", 2010, (revision requested) *ASME Journal of Engineering for Gas Turbines and Power*

**Panchagnula, Mahesh (Continued)**

S. Bhamidipati, N.P. Rayapati, J. Peddieson and M.V. Panchagnula, "Analytical solutions to fragmenting flow processes", 2010, (under review) *Mechanics Research Communications*

S. Bhamidipati, N.P. Rayapati, J. Peddieson and M.V. Panchagnula, "Analytical solutions for particulate pipe flows with fragmentation, evaporation, and diffusion", 2010, (under review) *Mechanics Research Communications*

V. Boovaragavan, V. Ramadesigan, M.V. Panchagnula and V. Subramanian, "A continuum representation for simulating discrete events for battery operations", 2010, *Journal of the Electrochemical Society*, 157(1) A98-A104

**Peddieson, John**

"Analytical Solutions to Fragmenting Flows," with N. Rayapati, S. Bhamidipati, and M. Panchagnula, presented at the AIChE Conference, Nashville, Tennessee, 2009.

"Modeling of Moisture Diffusion in Composites," with J. Liu, final report submitted to United Launch Alliance, 2009.

"Biaxial Stress Testing of Rohacell," with J. Liu, final report submitted to United Launch Alliance, 2009.

"Friction Stir Welding Heat Transfer: Quasisteady Modeling and its Validation," with S. Perivilli and J. Cui, ASME Journal of Manufacturing Science and Engineering, 131, 2009, pp. 011007-1-011007-8

**Ramirez, Guillermo**

Ramirez, F., P.R. Heyliger, Rappe, A., R. Leisure, G. Ramirez, "Acoustic Models of layered Quantum Dots," to be presented in 9<sup>th</sup> World Congress on Computational Mechanics APCOM2010, Australia

Ramirez, F., P.R. Heyliger, G. Ramirez, J. Tamasco, "Monte Carlo Simulation of Low Density Fiber Composites," to be presented in to be presented in 9<sup>th</sup> World Congress on Computational Mechanics APCOM2010, Australia

Ramirez, F., J. Tamasco, P.R. Heyliger, G. Ramirez, "Simulacion de Monter Carlo para Compuestos Fibrosos de Baja Densidad," VII Colombian Congress of Numerical Modeling, Bogota, 2009.

**Siraj, Ambareen**

Joseph McDaniel and Ambareen Siraj, "Towards A Secure Frequency Monitoring Network (FNET) System ", Proceedings: *6th Cyber Security and Information Intelligence Research Workshop (CSIIIR 10)* held in Oak Ridge National Lab, Oak Ridge, TN, April 21-April 23, 2010.

Summer Olmstead and Ambareen Siraj. "Cyberterrorism; The Threat of Virtual Warfare", *Crosstalk: The Journal of Defense Software Engineering*, November 2009.

**Gao, (David) Wenzhong**

Wenzhong Gao and Xi Chen, "Distributed Generation Placement Design and Contingency Analysis with Parallel Computing Technology," *Journal of Computers*, No. 3, 2009.

A. Kumar and Wenzhong Gao, "Distributed generation location optimization using mixed integer non-linear programming in hybrid electricity markets," *IET (IEEE) Generation, Transmission & Distribution*, 2009.

**Idem, Stephen**

Cantrell, C. and Idem, S. 2010, "On-Line Performance Modeling of the Convection Passes of a Pulverized Coal Boiler," *Heat Transfer Engineering*, Accepted for Publication.

Cantrell, C. and Idem, S. 2010, "U-Tube Assembly Heat Exchanger Performance Analysis Using Cyclic Iteration," *Heat Transfer Engineering*, Accepted for Publication.

Young, M.N., Darvennes, C., and Idem, S. 2009, "Aerodynamic Performance and System Effects of Propeller Fans," *HVAC&R Research*, Vol. 15, No. 2, pp. 231-254.

**Siraj, Ambareen**

Joseph McDaniel and Ambareen Siraj, "Towards A Secure Frequency Monitoring Network (FNET) System ", Proceedings: *6th Cyber Security and Information Intelligence Research Workshop (CSIIIR 10)* held in Oak Ridge National Lab, Oak Ridge, TN, April 21-April 23, 2010.

**Stretz, Holly**

Harrats, C., Groeninckx, G., book citation of TEM images : [Atlas on Phase Morphology](#), Taylor and Francis (CRC Press).



**(David) Wenzhong Gao**

A. V. Kulkarni, Wenzhong Gao, and J. Ning, "Study of Power System Load Shedding Scheme Based On Dynamic Simulation," IEEE Transmission and Distribution Conference and Exposition (IEEE Transmission & Distribution Conference and Exposition), New Orleans, April 19-22, 2010.

## BOOKS, BOOK CHAPTERS

---

### Siraj, Ambareen

David A. Dampier and Ambareen Siraj, Intrusion Detection Systems. In: *Enterprise Information Systems Assurance and System Security: Managerial and Technical Issues*, ed. M. Warkentin and R. B. Vaughn, Idea Group Publishing, Inc., Hershey: PA, February 2006.

### Stretz, Holly

Harrats, C., Groeninckx, G., book citation of TEM images : Atlas on Phase Morphology, Taylor and Francis (CRC Press).

**PRESENTATIONS****Stephen Canfield**

Panelist, "Selection of Computer Languages for Teaching Introductory Computer Languages for Teaching Introductory Programming for Mechanical Engineers," 2009 ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications, San Diego, CA, Aug 30 – Sept. 1, 2009.

**Glenn Cunningham**

"Energy Efficiency with Centrifugal Pumps," Taught workshop for North Carolina State University Energy Management Diploma Program, Roanoke, VA, November 2009

**Joseph Ojo**

Panelist, "Modeling and Steady-State Operation of a Rotary Power Flow Controller," 8<sup>th</sup> International Conference on Power Systems Operation and Planning, Abuja, Nigeria, January 14 – 25, 2010

### Abdelrahman, Mohamed

**Member :**

Institute of Electrical and Electronics Engineers (IEEE)  
ISA

### Alouani, Ali T.

**Member :**

IEEE Control Systems Society  
Optical Engineering

### Arce, Pedro

**Member :**

American Institute of Chemical Engineering (AIChE), Senior Member (since 2004)  
CAST, Chemical Reaction Engineering Divisions.  
American Chemical Society (ACS),  
Material, Colloids, and Environmental Sciences Divisions  
Society of Rheology  
American Society of Engineering Education (ASEE)  
Society of Industrial and Applied Mathematics (SIAM),  
Sigma Xi

### Badoe, Daniel A.

**Member :**

Assoc. Member, American Society of Civil Engineers  
Member, Institution of Transportation Engineers  
Member, Southeastern Division of the Institute of Transportation Engineers  
Volunteer, Transportation Research Board Committee on Travel Demand Forecasting  
Volunteer, Transportation Research Board Committee on Transportation Planning for Small and Medium-Sized Communities

### Biernacki, Joseph

**Member :**

Councilor to the American Electrophoresis Society (AES) Board of Advisors (2006-2009)  
Session Organizer – A Century of Process Principles, AIChE Annual Meeting, November, 2008.

### Canfield, Steve

**Member:**

American Society of Mechanical Engineering (ASME)  
American Society of Engineering Education (ASEE)  
Sigma Xi  
Phi Kappa Phi

**Honors/Awards**

Tennessee Technological University QEP Excellence Award, 2009 – 2010.  
Leighton E. Sissom Innovation and Creativity Award, College of Engineering, TTU, 2010.  
Tennessee Technological University, Presidential Faculty Fellow, 2007 – 2008  
Tennessee Board of Regents Academic Excellence Award, 2008  
Tennessee Department of Education Project of Excellence Award, 2008  
TVA Chair, Department of Mechanical Engineering, TTU, 2007 - 2009  
Brown Henderson Award, College of Engineering, TTU, 2005  
Click, Steven

**Member:**

Institute of Transportation Engineers  
American Society for Engineering Education

**Honors and awards.**

Exceptional Paper Award, the Transportation Research Board Committee on Traffic Signal Systems, 2008  
Tablet Initiative Recipient, Tennessee Technological University, 2007-08  
Exemplary Course Award, TTU, 2007  
Teaching/Learning Enhancement Grant to Support the QEP, 2006.

### Crouch, L.K.

**Member:**

American Concrete Institute International  
American Society for Testing and Materials  
Caplenor Faculty Research Award 2006-2007  
Chi Epsilon

### Cui, Jie

**Member:**

American Society of Mechanical Engineers (ASME)  
American Society of Heating, Refrigeration, Air-  
conditioning Engineers (ASHRAE)

### Cunningham, Glenn T.

**Member:**

AEE  
American Institute of Aeronautics and Astronautics  
American Society of Heating, Refrigeration, Air-  
conditioning Engineers  
American Society of Mechanical Engineers  
Phi Kappa Phi,  
Sigma Xi  
The Scientific Research Society

### Darvennes, Corinne.

**Member:**

Acoustical Society of America (ASA)  
American Society of Mechanical Engineers (ASME)

### Elkeelany, Omar.

**Member:**

American Society of Engineering Education (ASEE)  
IEEE Consumer Electronics Society  
Int'l. Academy of Science & Technology (IAST)  
International Society for Computers & their Applications (ISCA)

### EISawy, Ahmed

**Member:**

Sigma Xi  
Scientific Research Society, Full Member.  
American Society for Manufacturing Engineer  
American Welding Society  
American Society of Engineering Education  
American Association of Industrial Technology

### Fidan, Ismail.

**Member:**

National Coalition of Advanced Technology Centers (NCATC) – Professional & Institutional  
Tennessee Academy of Science (TAS)  
Society of Manufacturing Engineers (SME)  
Institute of Electrical and Electronics Engineers (IEEE) – Senior Member IEEE Components, Packaging, and  
Manufacturing Technology Society IEEE Robotics and Automation Society IEEE Systems, Man, and Cybernetics  
Society  
American Society of Mechanical Engineers (ASME)  
American Society for Engineering Education (ASEE)  
Association of Technology, Management, and Applied Engineering (ATMAE)

**Gao, (David) Wenzhong.****Member:**

Institute of Electrical & Electronics Engineers (IEEE)  
Power Engineering Society (PES)  
American Society for Engineering Education (ASEE)

**Professional Services:**

Session Chair, Distribution System Operation & Control I , NAPS 2009  
Technical Co-chair, Organizing Committee of 2009 IEEE Vehicular Power and Propulsion Conference (VPPC)

**Paper Reviewer****Journals**

*IEEE* Transactions on Energy Conversion  
*IET* Renewable Power Generation  
*IEEE* Transactions on Power Systems  
*IEEE* Transactions on Control System Technology  
*IEEE* Transactions on Industry Application

**Henderson, R. Craig****Member:**

Chi Epsilon  
ASCE/ACI/TMS Masonry Standards Joint Committee (MSJC)

**Honors and awards:**

Leighton Sissom Innovation and Creativity Award

**Huo, Xiaoming (Sharon)****Member:**

American Society of Civil Engineers (ASCE)  
American Concrete Institute (ACI)  
American Society for Engineering Education (ASEE)  
Precast/Prestressed Concrete Institute (PCI)

**Honors and awards:**

Who's Who Among America's Teachers, 2006

**Idem, Stephen A.****Member:**

American Society of Engineering Education (ASEE)  
American Society of Heating, Refrigerating and  
Air-Conditioning Engineers (ASHRAE)

**Darvennes, Corinne.****Member:**

Acoustical Society of America (ASA)  
American Society of Mechanical Engineers

**Kamal, Ahmed****Member:**

American Medical Physics Society  
American Biomedical Science Instrumentation  
Institute of Electrical & Electronic Engineers (IEEE)  
Institute of IEE, England

**L Borne, Sabine****Reviewer:**

Scientific journals (Computing, SIAM J. Sci. Comp.  
SIAM J. Mat. Anal.  
Journal Math

**Served on NSF Panels**

### Liu, Y. Jane

**Member:**

Associate Member, American Society of Civil Engineers (ASCE)  
American Society of Mechanical Engineers (ASME)  
USCAM

### Mahajan, Satish

**Member:**

Institute of Electrical and Electronic Engineers  
Lasers and Electro-Optics Society  
Power Engineering Society  
Electron Devices Society  
Sigma Xi  
Tau Beta Pi  
Eta Kappa Nu

### Mohr, Benjamin

**Member:**

American Concrete Institute (ACI)  
International Union of Laboratories & Experts in Construction Materials, Systems & Structures (RILEM) American  
Ceramic Society, Cements Division  
American Society of Civil Engineers (ASCE)  
American Society of Engineering Education (ASEE)

### Munukutla, Sastry

**Member:**

Associate Fellow, American Institute of  
Aeronautics and Astronautics (AIAA)  
American Society of Mechanical Engineers (ASME)

### Ojo, Joseph O.

**SeniorMember:**

Institute of Electrical and Electronics Engineers (IEEE)

**Fellow:**

Institute of Electrical Engineers (IEE), (UK)

**Member:**

IEEE Static Power Conversion Committee  
IEEE Industrial Drive Committee  
IEEE Electric Machine Committee

### Panchagnula, Mahesh

**Member:**

American Physical Society (APS)

### Pardue, Sally

**Member:**

American Society of Engineering Educators  
American Society of Mechanical Engineers  
Society of Experimental Mechanics  
Acoustical Society of America  
Society of Women Engineers  
Pi Tau Sigma  
Sigma Xi  
Tau Beta Pi  
Phi Kappa Phi

### Peddieson, John

**Member:**

Sigma Xi  
Phi Kappa Phi  
Society of Engineering Science  
American Academy of Mechanics  
American Filtration and Separation Society

### Radman, Ghadir

**Member:**

Institute of Electrical and Electronics Engineers (IEEE) Power Engineering Society (PES)

### Rajan, P.K.

**Member:**

Institute of Electrical and Electronics Engineers (IEEE)  
IEEE Acoustics, Speech, and Signal Processing Society  
IEEE Circuits and Systems Society  
IEEE Education Society  
American Society for Engineering Education (ASEE)  
Tennessee Academy of Science  
Sigma Xi  
The Society for Scientific Research

### Ramirez, Guillermo

**Member:**

Sigma Xi  
Scientific Research Society

### Sekar, Arun

**Member:**

Institute of Electrical and Electronics Engineers  
Power Engineering Society

### Stretz, Holly

**Member:**

American Chemical Society  
American Institute of Chemical Engineers  
Sigma Xi  
Society of Plastics Engineers  
Society of Women Engineers  
American Society of Engineering Educators (ASEE)



## JULY 2009

Newell Rubbermaid

Dan McFadden

Manchester, Tennessee

## DECEMBER 2010

Conco Systems

George Saxon  
President  
Noel Peters

Pennsylvania

Australia

**(David) Wenzhong Gao**

2009 UWIG Spring Technical Workshop and Annual Meeting in Philadelphia, PA, April 2009. The Workshop provided attendees with an expanded perspective on the status of wind in utility systems in the United States and other countries.

IEEE Central Tennessee Section Seminar held in Nashville, TN. Topic: Power Factor Correction Capacitors: Understanding the Benefits and Learning How to Safely Apply Them.

---

**GRADUATE THESIS/DISSERTATIONS AND OTHER STUDENT PUBLICATIONS**  
**Masters****Abhyankar, Shounak Ravindra**

Application of Wide Area Frequency Information from FNET to Power System Stabilizer (PSS)  
December 2009  
Dr. Ghadir Radman

**Arabandi, Mounika**

Simulation of Constant Power Profiles for Li ion Batteries  
December 2009  
Dr. Venkat R. Subramanian

**Gibbs, Daniel C.**

August 2009  
Laboratory Testing of Ducts and Fittings to Determine Pressure Loss Characteristics  
Dr. Stephen Idem

**Gottipati, Tejaswi**

December 2009  
Dr. Stephen Parke

**Gupta, Ankush**

December 2009  
A Feature Based Solution to the Forward Problem in Electrical Capacitance Tomography  
Dr. Mohamed Abdelrahman

**Hill, David**

December 2009  
Numerical Modeling of Flow and Heat Transfer in Friction Stir Welding  
Dr. Jie Cui

**Jaganathan, Sharanya**

December 2009  
Battery Charging Power Electronics Converter and Control for Plug-In Hybrid Electric Vehicle  
Dr. Wenzhong Gao

**Joshi, Anish**

December 2009  
Decentralized Frequency Control of a Multi-Machine Power System using Frequency Measurements from FNET  
Dr. Ghadir Radman

**Khaire, Swapnil S.**

December 2009  
Influence of Test Section Entrance Conditions on Straight Flat Oval Apparent Relative Roughness  
Dr. Stephen Idem

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**GRADUATE THESIS/DISSERTATIONS AND OTHER STUDENT PUBLICATIONS**  
**Masters****Komaragiri, Shalini Sushmitha**

December 2009

A SAG Monitoring Device Based on a Cluster of Code-Based GPS Receivers

Dr. Satish Mahajan

**Konisi, Sunil Naidu**

December 2009

Transport Property Models for Liquid Mixtures of CO<sub>2</sub> Refrigerant and PAG Lubricants in

Transcritical Heat Pumps

Dr. Stephen Idem

**O'Toole, Aaron Thomas**

May 2010

Design of a Mobile Robotic Welding System

Dr. Stephen Canfield

**Thomason, James Charles**

December 2009

Development of High Performance Structural Lightweight Portland Cement Concrete

Dr. Benjamin J. Mohr

**Wang, Ge**

December 2009

Doubly Fed Induction Generator (DFIG)-Based Wind Power Generation System Simulation using Real-Time Digital Simulator (RTDS)

Dr. Wenzhong Gao



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**GRADUATE THESIS/DISSERTATIONS AND OTHER STUDENT PUBLICATIONS  
PhD****Anantharaju, Neeharika**

May 2010  
Wetting by Moving Triple Lines  
Dr. Mahesh Panchagnula

**Jeedigunta, Manjeera**

August 2009  
Analytical and Compact Modeling of Highly Asymmetrical Independent Double-Gated Transistors  
Dr. Stephen Parke

**Robalino Vanegas, Diego Miguel**

August 2009  
Loss of Life of Medium Voltage Oil-Immersed Current Transformers under Thermal Accelerated Ageing  
Dr. Satish Mahajan

**Van Neste, Charles W.**

December 2009  
The Sound of Light: An Open Environment Photoacoustic Identification of Surface Adsorbed Molecules  
Dr. Satish Mahajan

## MS STUDENTS

Name	Dept.	Source of Support	Graduation Date	Advisor
Ahiakwo, Onyinyechukwu	ECE	ONR Winding Induction	Spring 2011	Dr. Ojo
Ahsan, Muhammad Nayeem	CEE	TDOT Traffic Signal Interchange	Spring 2011	Dr. Click
Balasubramanian, Srinath	ECE	CESR -- NSF Wind Power	Spring 2011	Dr. Gao
Bedir, Abdelkadir	ECE	ECE, CESR	Summer 2010	Dr. Alouani
Browning, Gregory Allen	CEE	TDOT Kingston Ash, ARRA Energy Center	Spring 2011	Dr. Crouch
Bryant, David Andrew	ME	NASA VU Space Grant, Tennessee State Department of Education EIME Grant	Spring 2011	Dr. Canfield
Bryant, Lindsay	CEE	NSF Transport Kinetics	Spring 2012	Dr. Mohr
Gokhale, Richa	ECE	CESR -- NSF Wind Power	Spring 2011	Dr. Gao
Hassan, Rabab	ECE	CESR	Spring 2011	Dr. Radman
Hill, David	ME	ARRA Energy Center	Fall 2009	Dr. Cui
Jaganathan, Sharanya	ECE	DOE ORNL High Voltage Lines	Fall 2009	Dr. Gao
Jayaraman, Jaianand	ECE	ECE, CESR MOE	Fall 2010	Dr. Sekar
Kambhampati, Rahul	ECE	CESR	Fall 2010	Dr. Radman
Khedkar, Sanket	ME	CESR	Summer 2010	Dr. Yoon
Kolluru, Lakshmi	ECE	CESR	Spring 2011	Dr. Radman
Kulkarni, Aboli	ECE	CESR	Summer 2010	Dr. Gao
Lloyd, Travis	CEE	TDOT Traffic Signal Interchange	Spring 2011	Dr. Click
Lonare, Amit	ECE	CESR	Summer 2010	Dr. Radman
Mahabal, Divya	ECE	CESR	Spring 2011	Dr. Radman
Matheny, Steven	CEE	NSF Transport Kinetics	Fall 2010	Dr. Mohr
McDaniel, Joseph Layton	CSC	CESR, CESR--DOE ORNL Smart Grid Research	Spring 2011	Dr. Siraj
Medley, Martin	CEE	CESR	Spring 2011	Dr. Crouch
Mihret, Melaku	ECE	ONR Winding Induction	Spring 2011	Dr. Ojo
O'Toole, Aaron	ME	RTT Remote Climbing Robot Phase II	Spring 2010	Dr. Canfield
Sontidpanya, Chayaon	ECE	ECE, CESR MOE	Spring 2011	Dr. Radman
Tamersi, Amarnath	ECE	CESR	Fall 2010	Dr. Radman
Thomason, James	CEE	CESR -- NSF Transport Kinetics, CEE -- NSF Transport Kinetics	Fall 2009	Dr. Mohr
Usman, Sulayman	ECE	ECE, CESR	Fall 2011	Dr. Radman
Vavilala, Sharath	ECE	CESR	Fall 2011	Dr. Radman
Watkins, Andrew	ECE	ECE, CESR MOE	Fall 2010	Dr. Gao
Zheglov, Vadim	ECE	ARRA Energy Center	Summer 2010	Dr. Gao

## PHD STUDENTS

Name	Dept.	Source of Support	Graduation Date	Advisor
Abounassif, Ahmed	ME	ARRA Energy Center	Spring 2012	Dr. Peddieson
Aganah, Kennedy	ECE	ONR Winding Induction	Spring 2012	Dr. Ojo
Aghazadeh Tabrizi, Mehriar	ECE	CESR	Spring 2012	Dr. Radman
Ambuken, Preejith	CHE	CHE, CESR	Spring 2012	Dr. Stretz
Ananatharaju, Neeharika	ME	CESR	Spring 2010	Dr. Panchagnula
Jamehbozorg, Arash	ECE	CESR	Fall 2013	Dr. Gao
Jayanthi, Aditya	ME	CESR, Goodrich Turbine	Spring 2012	Dr. Panchagnula Dr. Peddieson
Karimi-Davijani, Hossein	ECE	CESR, CESR--ORNL Smart Grid Research	Spring 2012	Dr. Ojo
Keshmiri, Seyed Nassar	ECE	CESR, ORNL Smart Grid Research	Fall 2012	Dr. Gao
Kulkarni, Devendra	ME	ASHRAE Duct Fittings Testing	Spring 2011	Dr. Idem
Ning, Jiaxin	ECE	CESR	Summer 2010	Dr. Gao
Ojo, Joshua	CEE	NSF Transport Kinetics	Spring 2012	Dr. Mohr
Rayapati, Narayana	ME	ARRA Energy Center, ULA Modeling of Moisture Diffusion	Summer 2010	Dr. Panchagnula
Thomas, Adam J.	ECE	ECE, CESR	Spring 2012	Dr. Mahajan
Zheng, Gang	ECE	CESR -- NSF Wind Power	Fall 2013	Dr. Gao

ARRA American Recovery and Reinvestment Act

ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers

EIME Early Intervention and Mechanical Engineering (Tennessee State Department of Education)

NASA National Aeronautics and Space Administration

NSF National Science Foundation

ONR Office of Naval Research

ORNL/DOE Oak Ridge National Laboratory/Department of Energy

RTT Robotic Technologies of Tennessee

TDOT Tennessee Department of Transportation

TVA Tennessee Valley Authority

ULA United Launch Alliance



## HOURLY STUDENT PERSONNEL

SM-13

### GRADUATE/UNDERGRADUATE STUDENTS

### MAJOR

Shounak Abhyankar	EE
Ahmed Abounassif	ME
Kennedy Aganah	EE
Mehriar Aghazadeh Tabrizi	EE
Onyinyechukwu Ahiakwo	EE
Preejith Ambuken	CHE
Neeharika Anantharaju	ME
Mounika Arabandi	CHE
Joel Badoe	CHEMISTRY
Srinath Balasubramanian	EE
Akshay Bauskar	CHE
Matthew Bedford	MATH
William G. Bennett	EE
Shilpa Beravelli	CHE
Dallas Bostian	IT
Gregory A. Browning	CE
David A. Bryant	ME
Lindsay Smith Bryant	CE
Nancy Burns	CHE
Aaron Crowley	CE
Roland DeCicco	ME
Samuel Elliott	IT
Jeffrey Foote	ME
Richa Gokhale	EE
Cayce Grissom	CE
Timothy Harrell	CE
Rabab Hassan	EE
David Hill	ME
Tristan Hill	ME
Michael Jordan Huddleston	ME
Sharanya Jaganathan	EE
Arash Jamehbozorg	EE
Aditya Jayanthi	ME
Jaianand Jayaraman	EE
Samantha Jeffries	CE
Anish Joshi	EE
Rahul Kambhampati	EE
Hossein Karimi-Davijani	EE
Sosthenes Karugaba	EE
Venkata Karusala	EE
Daniel Keaton	CE
Seyed Nasser Keshmiri	EE
Sanket Khedkar	EE
Lakshmi Kolluru	EE
Aboli Kulkarni	EE
Devendra Kulkarni	ME
Anuradha Kumar	EE
Ganapathy Kumar	EE
Amit Lonare	EE
Landon Longanecker	EE
Divya Mahabal	EE
Christopher Maier	MATH

## HOURLY STUDENT PERSONNEL

SM-13

### GRADUATE/UNDERGRADUATE STUDENTS (Continued)

### MAJOR

Steven Matheny	CE
Joseph McDaniel	CSC
Martin Medley	CE
Will Mefford	EE
Melaku Mihret	EE
Ananth Nalla	ME
Jiaxin Ning	EE
Joshua Ojo	CE
Olurotimi Osijo	EE
Aaron O'Toole	ME
Michael Pandak	EE
Bijaya Pokharel	EE
Jeremy Prince	ME
Kanakadurga Pulimera	EE
Parisa Radman	EE
Venkatasailanathan Ramadesigan	CHE
Benjamin Rose	EE
Chayanon Sontidpanya	EE
Amarnath Tamersi	EE
Adam Thomas	EE
Vivekanand Todakar	EE
Sulayman Usman	EE
Patrick Vogel	ME
Andrew Watkins	EE
Thomas Cody West	ME
Vadim Zheglov	EE
Gang Zheng	EE

### Work Study/Work Scholarship

Benjamin Ellis  
Steven Corum

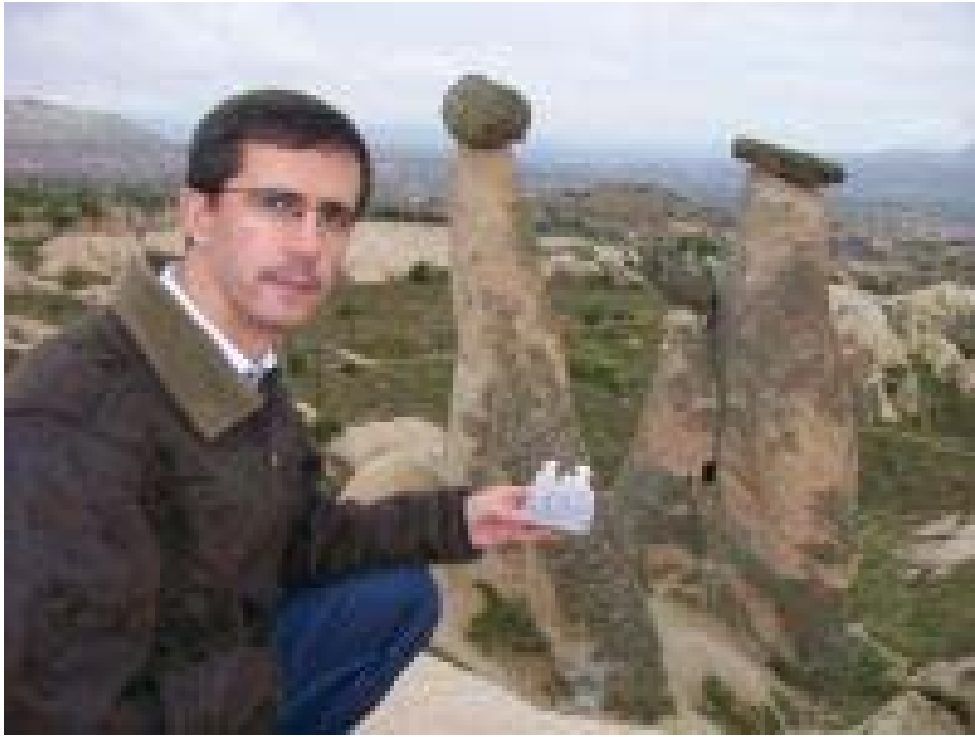
### Office Support

Candace Stafford



## BUDGET MATERIALS

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**Dr. Ismail Fidan, MIT Professor.**  
spent the last semester as a Fulbright Senior Scholar at Nigde University in Nigde, Turkey



**ACTUAL, PROPOSED, AND REQUESTED BUDGET**

**SCHEDULE 7**

	FY 2009-10 Actual			FY 2010-11 Proposed			FY 2011-12 Requested		
	Matching	Appropri.	Total	Matching	Appropri.	Total	Matching	Appropri.	Total
<b>Expenditures</b>	1,019,046	816,992	1,836,038	567,235	1,134,470	1,701,705	467,980	935,960	1,403,940
<b>Salaries</b>									
Faculty	300,671	114,396	415,067	169,930	109,907	279,837	120,390	99,400	219,790
Other Professional	76,631	225,034	301,665	31,796	286,920	318,716	4,150	276,540	280,690
Clerical/ Supporting	2,520	27,548	30,068	2,680	47,880	50,560	2,800	73,050	75,850
Assistantships	203,297	166,894	370,191	148,792	246,865	395,657	147,529	140,000	287,529
<b>Total Salaries</b>	<b>583,119</b>	<b>533,872</b>	<b>1,116,991</b>	<b>353,198</b>	<b>691,572</b>	<b>1,044,770</b>	<b>274,869</b>	<b>588,990</b>	<b>863,859</b>
Fringe Benefits	96,530	108,985	205,515	49,609	152,005	201,614	29,284	168,340	197,624
<b>Total Personnel</b>	<b>679,649</b>	<b>642,857</b>	<b>1,322,506</b>	<b>402,807</b>	<b>843,577</b>	<b>1,246,384</b>	<b>304,153</b>	<b>757,330</b>	<b>1,061,483</b>
<b>Non-Personnel</b>									
Travel	48,522	30,997	79,519	34,850	45,000	79,850	24,580	35,000	59,580
Software	0	7,516	7,516	3,000	3,000	6,000	3,000	2,000	5,000
Books & Journals	0	0	0	1,000	1,000	2,000	1,000	1,000	2,000
Other Supplies	133,024	30,592	163,616	31,612	73,533	105,145	53,059	55,130	108,189
Equipment	26,425	0	26,425	0	11,000	11,000	0	5,000	5,000
Maintenance	0	7,646	7,646	0	1,000	1,000	0	0	0
Scholarships	91,076	95,721	186,797	84,966	152,860	237,826	79,038	80,000	159,038
Consultants	40,350	1,242	41,592	9,000	1,000	10,000	3,150	0	3,150
Renovation	0	0	0	0	0	0	0	0	0
Other (Advertising)	0	421	421	0	2,500	2,500	0	500	500
<b>Total Non-Personnel</b>	<b>339,397</b>	<b>174,135</b>	<b>513,532</b>	<b>164,428</b>	<b>290,893</b>	<b>455,321</b>	<b>163,827</b>	<b>178,630</b>	<b>342,457</b>
<b>GRAND TOTAL</b>	<b>1,019,046</b>	<b>816,992</b>	<b>1,836,038</b>	<b>567,235</b>	<b>1,134,470</b>	<b>1,701,705</b>	<b>467,980</b>	<b>935,960</b>	<b>1,403,940</b>
<b>Revenue</b>									
New State Appropriation		883,400	883,400	0	882,600	882,600		935,960	935,960
Carryover State Appropriation		111,762	111,762	0	209,770	209,770		0	0
ARRA Funds	48,300	0	48,300	0	0	0			0
Carryforward ARRA Funds	43,200	0	43,200	0	0	0			0
MOE Funds	0	47,600	47,600	0	26,100	26,100			0
MOE Funds Carryover	0	0	0	0	16,000	16,000			
New Matching Funds	1,027,750		1,027,750	454,350		454,350	467,980		467,980
Previous Matching Funds	12,681		12,681	112,885		112,885			0
<b>Total Revenue</b>	<b>1,131,931</b>	<b>1,042,762</b>	<b>2,174,693</b>	<b>567,235</b>	<b>1,134,470</b>	<b>1,701,705</b>	<b>467,980</b>	<b>935,960</b>	<b>1,403,940</b>



**SCHEDULE 13A**

**ACTUAL PERSONNEL**

**TENNESSEE HIGHER EDUCATION COMMISSION  
CENTERS OF EXCELLENCE  
ACTUAL, 2009-2010**

Tennessee Technological University      Center for Energy Systems Research      June 30, 2010

a1. Faculty whose actual center effort will be at least 25% of full effort.

<b>Name and Faculty Rank</b>	<b>Department Affiliation</b>	<b>Center Effort in %</b>
Ali Alouani, Professor	Electrical and Computer Engineering	25
Steve Canfield,	Professor Mechanical Engineering	25
L. K. Crouch, Professor	Civil and Environmental Engineering	35
Omar Elkeelany, Assistant Professor	Electrical and Computer Engineering	25
Wenzhong (David) Gao, Asst. Prof.	Center for Energy Systems Research	86
Stephen Idem, Professor	Mechanical Engineering	30
Sabine LeBorne, Assistant Professor	Mathematics	30
Satish Mahajan, Professor	Electrical and Computer Engineering	40
Benjamin Mohr, Asst. Professor	Civil and Environmental Engineering	40
Joseph Ojo, Professor	Electrical and Computer Engineering	33
Mahesh Panchagnula, Asst. Prof.	Mechanical Engineering	25
John Peddieson, Professor	Mechanical Engineering	30
Ghadir Radman, Professor	Electrical and Computer Engineering	45

**\*NOTE 1: Center faculty members**      Number 13      FTE 4.69

a2. Faculty whose actual center effort will be less than 25% and all other personnel categories.

	<b>Number</b>	<b>FTE</b>
a. Faculty	11	1.23
b. Other Professionals	9	4.66
c. Clerical/Supporting	2	1.17
d. Assistantships	45	26.74
e. Hourly Students	82	6.5
<b>TOTAL, all categories</b>	<b>162</b>	<b>44.99</b>



**SCHEDULE 13B**

**PROPOSED PERSONNEL**

**TENNESSEE HIGHER EDUCATION COMMISSION  
CENTERS OF EXCELLENCE  
PROPOSED, 2010-2011**

Tennessee Technological University      Center for Energy Systems Research      June 30, 2010

a1. Faculty whose actual center effort will be at least 25% of full effort.

<b>Name and Faculty Rank</b>	<b>Department Affiliation</b>	<b>Center Effort in %</b>
Ali Alouani, Professor	Electrical and Computer Engineering	25
Steve Canfield, Professor	Mechanical Engineering	25
L. K. Crouch, Professor	Civil and Environmental Engineering	35
Stephen Idem, Professor	Mechanical Engineering	30
Sabine LeBorne, Assistant Professor	Mathematics	30
Satish Mahajan, Professor	Electrical and Computer Engineering	40
Benjamin Mohr, Asst. Professor	Civil and Environmental Engineering	40
Sastry Munukutla, Professor	Mechanical Engineering	45
Joseph Ojo, Professor	Electrical and Computer Engineering	33
Mahesh Panchagnula, Asst. Prof.	Mechanical Engineering	25
John Peddieson, Professor	Mechanical Engineering	30
Ghadir Radman, Professor	Electrical and Computer Engineering	45

**\*NOTE 1: Center faculty members.**      Number 12      FTE 4.03

a2. Faculty whose actual center effort will be less than 25% and all other personnel categories.

	<b>Number</b>	<b>FTE</b>
a. Faculty	12	1.65
b. .Other Professionals	6	3.55
c. Clerical/Supporting	1	1.00
d. Assistantships	40	25.00
e. Hourly Students	40	1.00
<b>TOTAL, all categories</b>	<b>111</b>	<b>36.23</b>

**SCHEDULE 13C****REQUESTED PERSONNEL**

**TENNESSEE HIGHER EDUCATION COMMISSION  
CENTERS OF EXCELLENCE  
REQUESTED, 2011-2012**

Tennessee Technological University      Center for Energy Systems Research      June 30, 2010

a1. Faculty whose actual center effort will be at least 25% of full effort.

<b>Name and Faculty Rank</b>	<b>Department Affiliation</b>	<b>Center Effort in %</b>
Ali Alouani, Professor	Electrical and Computer Engineering	25
Steve Canfield, Professor	Mechanical Engineering	25
L. K. Crouch, Professor	Civil and Environmental Engineering	35
Stephen Idem, Professor	Mechanical Engineering	30
Sabine LeBorne, Assistant Professor	Mathematics	30
Satish Mahajan, Professor	Electrical and Computer Engineering	40
Benjamin Mohr, Asst. Professor	Civil and Environmental Engineering	40
Joseph Ojo, Professor	Electrical and Computer Engineering	33
John Peddieson, Professor	Mechanical Engineering	30
Ghadir Radman, Professor	Electrical and Computer Engineering	45

\*NOTE 1: Center faculty members.      Number 10      FTE 3.33

a2. Faculty whose actual center effort will be less than 25% and all other personnel categories.

	<b>Number</b>	<b>FTE</b>
a. Faculty	9	1.29
b. Other Professionals	4	4.0
c. Clerical/Supporting	2	2.0
d. Assistantships	30	20.0
e. Hourly Students	40	2.0
<b>TOTAL, all categories</b>	<b>95</b>	<b>32.62</b>

**SCHEDULE 14A**

**2009-2010 PURCHASED EQUIPMENT**

**TENNESSEE HIGHER EDUCATION COMMISSION  
CENTERS OF EXCELLENCE  
PURCHASED EQUIPMENT, 2009-2010**

**INSTITUTION:** Tennessee Technological University  
**CENTER OF EXCELLENCE:** Energy Systems Research

**DATE:** June 30, 2010

**State Appropriations**

<b>Description</b>	<b>Number</b>	<b>Unit Cost</b>	<b>Total</b>
Subtotal, State Appropriations			\$0
Matching			
Description	Number	Unit Cost	Total
Concrete Cylinder End Grinding Machine (ARRA Energy Center 531692)	1	\$18,425	\$18,425
Rapid Chloride Permeability Test System (TDOT PCC 539274 and 539277)	1	\$ 8,000	\$ 8,000
Subtotal, Matching			\$26,425
GRAND TOTAL			\$26,425
Grand Total	Matching		Appropriation
\$26,425	\$26,425		\$0

**SCHEDULE 14B**

**PROPOSED EQUIPMENT**

TENNESSEE HIGHER EDUCATION COMMISSION  
CENTERS OF EXCELLENCE  
PROPOSED EQUIPMENT, 2010-2011

INSTITUTION: Tennessee Technological University  
CENTER OF EXCELLENCE: Energy Systems Research

DATE: June 30, 2010

State Appropriations

Description	Number	Unit Cost	Total
Network File Server	1	\$11,000	\$11,000
Subtotal, State Appropriations			\$11,000

Matching

Description	Number	Unit Cost	Total
Subtotal, Matching			\$0
GRAND TOTAL			\$11,000

Grand Total	Matching	Appropriation
\$11,000	\$0	\$11,000

**SCHEDULE 14C**

**REQUESTED EQUIPMENT**

TENNESSEE HIGHER EDUCATION COMMISSION  
CENTERS OF EXCELLENCE  
REQUESTED EQUIPMENT, 2011-2012

INSTITUTION: Tennessee Technological University  
CENTER OF EXCELLENCE: Energy Systems Research

DATE: June 30, 2010

**State Appropriations**

<b>Description</b>	<b>Number</b>	<b>Unit Cost</b>	<b>Total</b>
Research Laboratory Equipment	1	\$5,000	\$5,000
Subtotal, State Appropriations			\$5,000

**Matching**

<b>Description</b>	<b>Number</b>	<b>Unit Cost</b>	<b>Total</b>
Subtotal, Matching			0

GRAND TOTAL \$5,000

Grand Total	Matching	Appropriations
\$5,000	\$0	\$5,000

**SCHEDULE 15A**  
**BASE SUPPORT AND NON-EQUIPMENT MATCHING**

**ACTUAL 2009-2010**

<b>Budget Account Numbers</b>	<b>2009-2010 Actual Expenditures</b>
2-10406, 2-10407, 2-10409, 2-10436, 2-10437, 2-10438, 2-10411, 2-10412, 2-10413, 2-10416, 2-10417, 2-10418, 2-10421, 2-10423, 2-10431, 2-10432, 2-10426, 2-10427, 2-10428, 2-10460, 2-45016, 2-29144	7,793,327
<b>TOTAL BASE SUPPORT</b>	<b>7,793,327</b>

**Non-Equipment Matching  
 Restricted Accounts  
 (No equipment or indirect costs included)**

<b>Account Number</b>	<b>Project Title and Sponsor</b>	<b>Amount</b>
538233	Laboratory Testing of Increased Area (Pressed) Saddle Tap Tees to Determine Loss Coefficients (Spiral Duct Manufacturers Association SPIDA)	16,086
536229	Modeling of Moisture Diffusion in Composites (United Launch Alliance ULA)	37,993
531651	Algebraic Hierarchical Matrix Preconditioners for Two- and Three-Dimensional Saddle Point Problems (National Science Foundation NSF CCLI ARRA)	24,584
531652	CAREER: Wind Power -- Multi-Level Control, Intelligent Grid Integration and Real Time Digital Simulation (National Science Foundation NSF ARRA)	57,348
531255	Conference: NSF Travel Support for Students Attending the 5th IEEE Vehicular Power and Propulsion Conference (VPPC 2009) (National Science Foundation)	5,800
539510	Enabling Children with Disabilities and Their Families in Tennessee through Technology EIME Project (Preschool) (State Department of Education -- Division of Special Education)	25,926
539511	Enabling Children with Disabilities and Their Families in Tennessee through Technology EIME Project (School Age) (State Department of Education -- Division of Special Education)	6,481

**SCHEDULE 15A****BASE SUPPORT AND NON-EQUIPMENT MATCHING****Non-Equipment Matching  
Unrestricted Matching  
(No equipment or indirect costs included)**

<b>Account Number</b>	<b>Project Title and Sponsor</b>	<b>Amount</b>
539334	High Voltage Transmission Lines -- Phase II (TN) -- Smart Grid Research	297,491
536350	Eulerian Multi-Fluid Model of Air Blast Atomization (Delavan, Inc., subsidiary of Goodrich Corporation (Turbine Fuel Technologies))	32,115
539273	Preliminary Investigation of Beneficial Uses of Kingston Ash Material -- Federal (Tennessee Department of Transportation TDOT)	41,739
533215	Preliminary Investigation of Beneficial Uses of Kingston Ash Material -- State (Tennessee Department of Transportation TDOT)	10,435
531641	Recovery Act: Multi-Level Energy Storage and Controls for Large Scale Wind Energy Integration (U. S. Department of Energy)	94,128
539277	Optimum Air Content Range (Plastic and Hardened) for TDOT Class D Portland Cement Concrete (PCC) -- State (Tennessee Department of Transportation TDOT)	8,835
539274	Optimum Air Content Range (Plastic and Hardened) for TDOT Class D Portland Cement Concrete (PCC) -- Federal (Tennessee Department of Transportation TDOT)	35,338
539275	Simplified Live Load Distribution Factor Equation for Tennessee Highway Bridge Design -- Federal (Tennessee Department of Transportation TDOT)	22,610
539276	Simplified Live Load Distribution Factor Equation for Tennessee Highway Bridge Design -- State (Tennessee Department of Transportation TDOT)	5,650
539278	Field Evaluation of Traffic Signal Based Interchange Treatments (Year 1) -- Federal (Tennessee Department of Transportation TDOT)	46,609
533216	Field Evaluation of Traffic Signal Based Interchange Treatments (Year 1) -- State (Tennessee Department of Transportation TDOT)	11,652

## SCHEDULE 15A

### BASE SUPPORT AND NON-EQUIPMENT MATCHING

(No equipment or indirect costs included)

<b>Account Number</b>	<b>Project Title and Sponsor</b>	<b>Amount</b>
532344	Performance Optimization and Extended Speed Control of Multi-Phase Winding Induction (Office of Naval Research ONR)	140,723
535244	Development of a Wire Core Transformer (Buswell Energy, LLC)	53,763
538597	Power-Test-Service Account	16,044
531692	ARRA Energy Center	29,875
	<b>Subtotal, Restricted Accounts</b>	<b>1,021,225</b>

**Unrestricted Matching**  
(No equipment or indirect costs included)

<b>Account Number</b>		<b>Amount</b>
229342	TTU Research	12,550
229638	Gao IC Faculty Energy Systems Research	5,540
229660	Munukutla IC Faculty Energy Systems Research	2,640
229691	Beard IC Faculty Energy Systems Research	1,490
229732	Craven IC Faculty Energy Systems Research	180
	<b>Subtotal, Unrestricted Accounts</b>	<b>22,400</b>

**Other Matching**  
(Gifts and other non-equipment support not having account numbers)

1.	TVA Upperclassman Scholarship	1,500
2.	Excellence in Electric Power Scholarship	4,500
3.	Carryover Match, Operations, 2008-2009	55,881
	Subtotal, Other Matching	\$61,881
	<b>TOTAL, NON-EQUIPMENT MATCHING</b>	<b>\$1,105,506</b>



**SCHEDULE 15B**  
**PROPOSED BASE SUPPORT AND NON-EQUIPMENT MATCHING**

**PROPOSED, 2010-2011**

**2010-2011**  
**Proposed Expenditures**

**Budget Account Numbers**

2-10406, 2-10407, 2-10409, 2-10436, 2-10437, 2-10438, 2-10411, 2-10412, 2-10413, 2-10416, 2-10417, 2-10418, 2-10421, 2-10423, 2-10431, 2-10432, 2-10426, 2-10427, 2-10428, 2-10460, 2-45016, 2-29144	8,027,127
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<b>TOTAL BASE SUPPORT</b>	<b>8,027,127</b>
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**Non-Equipment Matching**

Restricted Accounts

(No equipment or indirect costs included)

1. National Science Foundation (NSF)	90,797
2. Office of Naval Research (ONR)	55,691
3. Tennessee Department of Transportation	194,349
4. Tennessee State Department of Education	32,407
5. Advanced Technologies Institute	17,212
6. Goodrich Turbine Technologies	53,344

<b>Subtotal, Restricted Accounts</b>	<b>443,800</b>
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**Unrestricted Accounts**

<b>Account Number</b>	<b>Amount</b>
TTU Research	10,550
<b>Subtotal, Unrestricted Accounts</b>	<b>0</b>
<b>TOTAL, NON-EQUIPMENT MATCHING</b>	<b>454,350</b>

**SCHEDULE 15C**  
**BASE SUPPORT AND NON-EQUIPMENT MATCHING**

**REQUESTED, 2011-2012**

**2011-2012  
Proposed Expenditures**

**Budget Account Numbers**

2-10406, 2-10407, 2-10409, 2-10436, 2-10437, 2-10438, 2-10411, 2-10412, 2-10413, 2-10416, 2-10417, 2-10418, 2-10421, 2-10423, 2-10431, 2-10432, 2-10426, 2-10427, 2-10428, 2-10460, 2-45016, 2-29144	8,267,941
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<b>TOTAL BASE SUPPORT</b>	<b>8,267,941</b>
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**Non-Equipment Matching**

Restricted Accounts

(No equipment or indirect costs included)

1. National Science Foundation (NSF)	191,717
2. Office of Naval Research (ONR)	77,828
3. Tennessee Department of Transportation	139,348
4. Tennessee State Department of Education	32,407
5. Power-Test-Service Account	26,680
<b>Total</b>	<b>467,980</b>

**Unrestricted Accounts**

Account Number	Amount
<b>Subtotal, Unrestricted Accounts</b>	<b>0</b>
<b>TOTAL, NON-EQUIPMENT MATCHING</b>	<b>467,980</b>

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**August 2010**

**Tennessee Tech University**

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**AA/EEO/Title IX/Section 504/ADA University.**