



# 46th Annual Report

TAUFIK, Director of EPI and Professor of Electrical Engineering

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## LETTER FROM DIRECTOR

Greetings,

I am pleased to present this year's Electric Power Institute's annual report at Cal Poly State University covering the academic year 2016 – 2017.

EPI has the mission to develop the best possible educational research and service in the area of power and energy systems, renewable energy, and power electronics. The EPI faculty initiates and carries out an expanded program of senior and graduate student research projects of a basic and widely applicable nature with the support of the program funds provided by the sponsors.

The resources of the Electric Power Institute (EPI) enhance the strong reputation of excellence that the Electrical Engineering Program at Cal Poly has maintained. The faculty, students, and the power program have also benefited from the continued work of EPI and the financial support it receives from the power industry.

This past year we continued our efforts in revamping the power program through the “Advanced Power System Initiatives”. The initiatives entail our short and long term goals in modernizing our power curriculum by revising existing power courses, developing new power courses, and upgrading the power laboratories. I am happy to report that we received several donations from Power Integrations and Schweitzer Electric Laboratory in terms of equipment. I am also pleased to mention that we received a couple of grants that will help us in the development of a new microgrid lab. We continue working with SEL Inc. to get equipment donation that will be used for the microgrid lab and power system protection lab. EPI continued to host technical seminars and presentations where engineers from power industries visited and gave talks to our students and faculty.

This coming year we continue our commitment in supporting the power program at Cal Poly through active involvement with students, faculty, and the power industry. For any questions about this report or the EPI in general, please contact me via email at [taufik@calpoly.edu](mailto:taufik@calpoly.edu). Thank you very much for your time and attention.

Sincerely yours,

A handwritten signature in black ink, appearing to be 'Taufik', with a stylized, overlapping loop and a long horizontal stroke extending to the right.

Taufik, Professor, Electrical Engineering Department

## INTRODUCTION

In 1971, the university approved the release of a preliminary proposal, which outlined plans for the establishment of an Electric Power Institute. The proposal represented the culmination of many hours of effort by a small group of faculty in the Electrical Engineering Department. As stated in the proposal, the Electric Power Institute was established to serve as an interface between the university and the electric power industry, also serving as a center for electric-power-oriented activity within the university. The Institute also supports the administration of other projects in Electrical and Computer Engineering.

Throughout the Electric Power Institute's long years of existence, many companies have supported its activities. This support comes in the form of financial contributions, workshop sponsorships, workshop participation, seminar speakers, equipment donations, consulting opportunities for our faculty, and summer job opportunities for students and faculty.

We encourage our supporting companies to visit our campus and meet the faculty and administration, familiarizing themselves with our facilities. We find that these one-to-one visits strengthen our industrial ties, leading to a better understanding of the mutual needs of university and industry.

Each year of operation, the Institute has produced an annual report, this being our 46<sup>th</sup>. This report is primarily a summary of the Institute's activities for the 2016-2017 academic year. A projection of activities and budget for the 2017-2018 academic year is also included in this report.

## **ORGANIZATION**

The Electric Power Institute was the first institute to be formed at Cal Poly, making it necessary for the university to establish a set of operational guidelines to insure that the Institute's activities conformed to established university procedures. For example, funds contributed to the university must be accepted and disbursed in accordance with the rigid state laws and under the supervision of the Cal Poly Corporation.

As approved by the university, the leadership of the Institute is the responsibility of the director, who reports to the Dean of the College of Engineering and the Interim Vice President for Research and Economic Development. On a regular basis the director consults with the Advisory Committee, whose members are selected by the director of the Institute with the Dean's approval.

### **Director**

Taufik, Professor, Electrical Engineering Department

### **Advisory Boards**

In prior years, EPI has the following advisory board members. However, their memberships have not yet been renewed. Therefore, for this past academic year EPI has not appointed an advisory board. Since the organization document for EPI is old and outdated, I further intend to revise the document this academic year with the consultation and approval from the College of Engineering Dean's office, which include the policy on the formation of the advisory board memberships.

Electrical Engineering Department

Ali Shaban, Professor, Electrical Engineering Department

Ahmad Nafisi, Professor, Electrical Engineering Department

Non-University

Laurence Abcede, Engineering Manager, San Diego Gas and Electric

Daniel Spaizman, Engineer II, San Diego Gas and Electric

### **Members of the Electric Power Institute**

Electrical Engineering Department

Bill Ahlgren

Dale Dolan

Helen Yu

Majid Poshtan

Ahmad Nafisi

Ali Shaban

Administrative Assistant

2016 – 2017: Grace Larson

## INSTITUTE ACTIVITIES

### 1) Seminar

As part of the Electric Power Institute's continuing program to bring industry to campus, our seminar program brings individuals that are considered to be experts in their field to Cal Poly. Below are the seminars sponsored by EPI for 2016-2017:

#### **SEL Digital Relay Seminar, 2/8/17 – 2/9/17**

**Building 20-101, 8:00 am – 4:00 pm**

Alejandro Avendaño, Ph. D., P.E.

Application Engineer II – Protection, Schweitzer Engineering Laboratories

2010 Crow Canyon Place, Suite 150, San Ramon, CA 94583



#### **LTSpice for Circuit Analysis and Simulation Seminar**

**Building 20-136, 3/4/17, 10:00 am – 1:00 pm**

Dave Green and Glen Fabian, Linear Technology





## **Substation Engineering**

Building 20A Lobby, 5/4/17, 6:00 pm – 7:30 pm

John Villalpando, PE

Substation Engineering & Design Supervisor – North Coast

Pacific Gas & Electric



## **2) Outreach Event**

- Career Day at Pioneer Valley High School, Santa Maria



## **3) Publications**

- Taufik, "Teaching the Hands-on Magnetic Design Laboratory Course: Experience and Lessons Learned", Proc. of 2017 ASEE PSW Conference, April 2017.
- K. Pretzer, A. Shaban, Taufik, "Development of Laboratory Experiments for Protection and Communication in Radial and Bidirectional Power Systems", Proc. of 2017 ASEE PSW Conference, April 2017.

- A. Tjahjono, A. Priyadi, M. Pujiantara, M. H. Purnomo, Taufik, A. Shaban, X. Yu, "Modeling Characteristic Curves of Digital Overcurrent Relay (DOCR) for User-defined Characteristic Curve using Artificial Neural Network", Proc. of the 2016 International Conference on Computational Science and Computational Intelligence, December 2016.
- K. Htoo, Taufik, and G. Larson, "Multiple-Input Bridge Converter for Connecting Multiple Renewable Energy Sources to a DC System", Proc. of 2016 Future Technologies Conference, December 2016.
- A. Medina, A. Salguero, Taufik, and A. Parastiwi, "Phase Shifted Boost-Cuk Converter for Renewable Energy Applications", Proc. of 2016 3rd ICNERE & 8th EECCIS Conference, October 2016.
- M. Taufik and Taufik, "Modeling and Simulation of Solar Powered DC Water Pump", Proc. of 2016 FORTEI National Seminar, October 2016.
- D. Magdefrau, Taufik, M. Poshtan, and M. Muscarella, "Analysis and Review of DC Microgrid Implementations", Proc. of International Seminar on Application for Technology of Information and Communication Science and Technology, August 2016.
- Taufik, D. Sawitri, and M. Muscarella, "Power Quality Analysis of Variable Frequency Drives Connected to a Reactively Compensated Mixed Load System", Proc. of International Seminar on Technology of Information and Communication Science and Technology, August 2016.
- Taufik, and M. Muscarella, "Development of DC House Prototypes as Demonstration Sites for an Alternate Solution to Rural Electrification", Proc. of the 6th International Annual Engineering Seminar, July 2016.
- M. Muscarella, J. Mitchell, and Taufik, "Design Considerations of Diode Source Protection in Multiple Buck Converter", Proc. of International Conference on Applied Electrical, Electronics, and Informatics Engineering, July 2016.
- C. Aarstad, Taufik, A. Kean, and M. Muscarella, "Development of Arc Fault Interrupter Laboratory Testing for Low Voltage DC Electricity", Proc. of International Seminar on Intelligent Technology and Its Applications, July 2016.
- R. I. Putri, A. Priyadi, M.H. Purnomo, M. Pujiantara, and Taufik, "Optimum Control Strategy of Grid Connected PMSG Wind Turbine Based on Energy Storage System", Proc. of International Seminar on Intelligent Technology and Its Applications, July 2016.

#### **4) Short Courses, Conference & Special Institute Attended**

- Guest Speaker, "The DC House Project for Rural Electrification", Syarikat Islam, Jakarta, June 2017.
- Visiting Professor, Electrical Engineering Department, Universitas Padjadjaran, Jatinangor, August 2016.
- Guest Speaker, "Cal Poly at a Glance", Universitas Pendidikan Indonesia, Bandung, August 2016.
- Guest Speaker, "The DC House Project as an Alternate Solution to Rural Electrification", Universitas Pertamina, Jakarta, August 2016.
- Keynote Speaker, "Intelligent Systems in DC House for Residential Electricity", International Seminar on Application for Technology of Information and Communication Science and Technology, Semarang, August 2016.



- Invited Lecture, "Seminar on How to Write a Successful Paper", Universitas Muhammadiyah Yogyakarta, August 2016.
- Keynote Speaker, "Residential Electricity the DC House Way: Progresses, Challenges, and Opportunities", the 6th International Annual Engineering Seminar, Yogyakarta, August 2016.
- Keynote Speaker, "Intelligent Systems in DC House for Residential Electricity", International Seminar on Intelligent Technology and Its Applications, Lombok, July 2016.
- Guest Speaker, "Rural Electrification: The DC House Solution", Universitas Mataram Lombok, July 2016.
- Keynote Speaker, "The DC House Project as an Alternate Solution to Rural Electrification", International Conference on Applied Electrical, Electronics, and Informatics Engineering, Pontianak, July 2016.

#### 5) Cash Donation

- Total Alumni cash donation \$8,211.64
- Total Company cash donation \$10,000

#### 6) Equipment Donation

- LED Reference Design Kits, Power Integrations
- Magnetic Components, Wurth Elektronik

#### 7) Grants

- Cal Poly Microgrid Solar Array and Central Controller, CPConnect, College of Engineering, \$2,500, A. Davol, Taufik
- Microgrid System Protection, Electric Power Research Institute, \$5000, Taufik
- Development of Photovoltaic-powered DC Modular Electrical System, Research, Scholarship, and Creative Activities (RSCA), Grant program, the Office of Research and Economic Development, \$13,849.20, P. Schwartz, Taufik, A. Tubeileh
- PSCAD Modeling of Microgrid and Its Components, San Diego Gas and Electric, \$10,000, Taufik, Students: Joseph Lee, Kyle Hasan

#### 8) MS Theses

The following is a list of Master's theses fully or partially funded by the Institute:

Student's Name	MS Thesis Title
Khalid Althomali	Energy Management System Modeling of DC Data Center with Hybrid Energy Sources Using Neural Network
Angelo Gallardo	Design and Construction of 1800W Modular Multiple Input Single Output Non-Isolated DC-DC Converters
Joseph Lee	PSCAD Modeling of Battery Energy Storage Systems

Nathaniel Lentz	A Modified Boost Converter with Reduced Input Current Ripple
Kyle Hasan	PSCAD Modeling and Stability Analysis of A Microgrid
Maxwell Muscarella	Alternate Models of Electrical Distribution: Utilizing AC/DC Load Distribution and MISO with AC/DC Generation Sources

## 9) Visiting Scholar

In Fall 2016, EPI hosted a visiting scholar Anang Tjahjono from the Institut Teknologi Sepuluh Nopember (ITS) in Surabaya, Indonesia. He is a PhD student at ITS with research entitled Adaptive modified firefly algorithm for optimal coordination of overcurrent relays. While at Cal Poly, Mr. Tjahjono conducted his research with Professor Taufik as his advisor. The research has produced one peer-reviewed conference paper and technical journal.

## 10) Club Activities

Professor Taufik is the advisor for the Cal Poly Chapter of the Power and Energy Society (PES). Samuel Lopez was the president of the Power and Energy Society during 2016-2017. The club holds bimonthly meetings, arranges industry field trips, and brings in industry speakers for seminars. They made field trips to several companies including Helix Electric, Roseville Electric and Pacific Gas & Electric. They arranged info sessions for companies offering summer internships and employment. EPI has contributed to the Power Engineering Society Club activities.

## INSTITUTE PLANS

Much of the work of the Institute were completed in AY16-17 with some are still ongoing and will continue in its present form. Specific plans for the upcoming year are indicated below:

### 1. **Power Engineering Presentations and Seminars**

EPI continues to host professional power engineering seminars for students and faculty on various topics of power engineering. Seminars will be held once each quarter during the normal academic year. Guest seminar speakers will be invited from sponsoring companies and the power industry in general. Whenever possible, we seek to include Cal Poly alumni who have been working in the field for several years. These speakers provide special insight for current Cal Poly students.

### 2. **Sustainable Energy Laboratory.**

The Institute will continue to support the development of Sustainable Energy Laboratory located in 20-150. Recently, the construction of the 18.5-acre 4.5MW solar farm by REC Solar on campus will help enhance the development of the Sustainable Energy Lab. This is made possible through the academic component of the project which provides roughly 30kW photovoltaic systems for teaching/learning activities. The 30kW solar sandbox is currently planned to reside next to building 20 (where electrical engineering labs are located).

### 3. **Professional Development**

As part of our continuing effort in the area of professional development, the Institute supports faculty and students attendance at short courses, and conferences.

### 4. **Student Projects**

EPI continues to support senior projects, master theses, and research efforts related to power systems, renewable energy, and power electronics.

### 5. **Financial Support**

We will continue to solicit support for the Institute from the power industry. Support will be requested for both the ongoing program of the Institute and for sponsored projects for graduate students and senior projects.

## FINANCIAL STATEMENT

The following financial statement is a reflection of the 2016-2017 operating statement of EPI as provided by the Cal Poly Foundation:

<b>BEGINNING BALANCE</b>			<b>\$72,197.18</b>
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<b>INCOME</b>	Donation – Companies	10,000.00	
	Donation – Individuals	8,211.64	
	<b>TOTAL INCOME</b>		<b>\$18,211.64</b>
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<b>EXPENSES</b>	Operational Expense	4,052.80	
	Sustainable Energy Lab	0	
	Power Electronic Lab	966.95	
	Power Electronic Project	1,112.23	
	Meetings	0	
	Salary	0	
	Little Box Project	2,229.57	
	Travel Expense	0	
	<b>TOTAL EXPENSES</b>		<b>\$15,037.63</b>
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<b>REMAINING BALANCE</b>			<b>\$75,248.85</b>
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## **PROJECTED BUDGET FOR AY 2017-2018**

<b>INCOME</b>	Industry and Individual Gifts	\$20,000.00
	<b>TOTAL INCOME</b>	<b>\$20,000.00</b>
<b>EXPENSES</b>	Administrative Support Services	750.00
	Benefits	750.00
	Operational Expenses	2,000.00
	Equipment	5,000.00
	Travel Expenses	5,000.00
	Seminar/Short Courses	5,000.00
	<b>SUBTOTAL</b>	18,500.00
	Corporation Fiscal Charges	1,500.00
	<b>TOTAL EXPENSES</b>	<b>\$20,000.00</b>