

## Scholarships for Future Leaders in Electric Energy and Smart Grid

### **Prof. Ali Mehrizi-Sani , Washington State University**

Ali Mehrizi-Sani received the B.Sc. degrees in electrical engineering and petroleum engineering from Sharif University of Technology, Tehran, Iran, both in 2005. He received the M.Sc. degree from the University of Manitoba, Winnipeg, MB, Canada, and the Ph.D. degree from the University of Toronto, Toronto, ON, Canada, both in electrical engineering, in 2007 and 2011. He is currently an Assistant Professor at Washington State University, Pullman, WA, USA. He was a Visiting Professor at Graz University of Technology, Graz, Austria, in Nov. 2014, Jan. 2016, and Nov.-Dec. 2016. His areas of interest include power system applications of power electronics and integration of renewable energy resources. Dr. Mehrizi-Sani is an editor of IEEE Transactions on Power Systems, IEEE Transactions on Power Delivery, IEEE Transactions on Energy Conversion, and IEEE Power Engineering Letters. He is also an editor of Wiley International Transactions on Electrical Energy Systems. He is the Chair of IEEE Task Force on Dynamic System Equivalents and the Secretary of the CIGRE Working Group C4.34 on Application of PMUs for Monitoring Power System Dynamic Performance. He was a recipient of the WSU VCEA Reid Miller Excellence in Teaching Award in 2016, the NSERC Postdoctoral Fellowship in 2011, and the Dennis Woodford prize for his M.Sc. thesis in 2007. He was a Connaught Scholar at the University of Toronto.

### **Prof. Chen-Ching Liu, Washington State University**

Boeing Distinguished Professor and Director of Energy Systems Innovation Center, Washington State University, Pullman. Dr. Liu received his Ph.D. from University of California, Berkeley. He was Professor and Associate Dean of Engineering at University of Washington and Palmer Chair Professor at Iowa State University. Before joining WSU, Dr. Liu was Professor and Acting/Deputy Principal of College of Engineering, Mathematical and Physical Sciences, University College Dublin, Ireland. He is a Fellow of the IEEE and Member of Washington State Academy of Sciences.

### **Dr. Robert G. Olsen, Washington State University**

Prof. Olsen received the BS degree in electrical engineering from Rutgers University, New Brunswick, NJ in 1968 and the MS and Ph.D. degrees in electrical engineering from the University of Colorado, Boulder, CO in 1970 and 1974 respectively. While in Boulder, he worked for Westinghouse Georesearch Laboratory. He has been a member of the electrical engineering faculty at Washington State University since 1973 and holds the rank of professor. Between 2003 and 2013, he served as the Associate Dean for Undergraduate Programs and Student Services at Washington State University. He has been an NSF Faculty Fellow at GTE Laboratories in Waltham, MA, a visiting scientist at ABB Corporate Research in Västerås, Sweden and at the Electric Power Research Institute (EPRI) in Palo Alto, CA and a Visiting Professor at the Technical University of Denmark. His research interests span all aspects of electromagnetics issues in power transmission and has resulted in approximately 85 publications in refereed journals and approximately 150 conference publications/presentations. He is also one of the authors of the AC Transmission Line Reference Book – 200 kV and Above which is published by the Electric Power Research Institute (EPRI) and the author of the recently published two volume book, High Voltage Overhead Transmission Line Electromagnetics. He is a Fellow of the IEEE and an Honorary Life member of the IEEE Electromagnetic Compatibility Society

# Scholarships for Future Leaders in Electric Energy and Smart Grid

Ali Mehrizi-Sani, Chen-Ching Liu, and Robert G. Olsen  
Washington State University

## Abstract

Electrical power is critical to the U.S. economy. However, many of the power engineering workforce are eligible for retirement in the near future. The loss of their years of experience is a serious threat to the power system operation, reliability, and efficiency. Building on our strong power program with a high national and international reputation in education and research and using a grant funding from the National Science Foundation's Scholarships in STEM (S-STEM) program, we establish a scholarship program for recruitment, retention, and mentoring of future power engineering leaders in electric energy and smart grid. Our specific objectives are to increase the number of students in the following groups in power engineering by 50%: (i) Bachelor's, (ii) Master's, (iii) underrepresented minorities, and (iv) women, by providing opportunities for lower division students, community college students, and four-year university students to study in Bachelor's and Master's degrees.

## Introduction

It is well recognized nationally that the United States is in urgent and critical need for the power and energy engineering workforce [1]–[3]. The severity and urgency of the problem has already been recognized in the 2007 Long-Term Reliability Assessment [1] by North American Electric Reliability Corporation (NERC); it was recognized that “the loss of industry workers and their years of accumulated experience due to retirement is a serious threat to the bulk power system reliability, exacerbated by the lack of new recruits entering the field.”

The goal of this program is to significantly increase enrollment in electric energy-related STEM majors at Washington State University (WSU) and prepare them for the workforce. To successfully achieve this goal, four components are needed: (i) students interested in energy-related fields, (ii) industry interested in hiring qualified students (with a Bachelor's or Master's degree), (iii) an institutional infrastructure at WSU, and (iv) funds for scholarships to enable students to attend WSU. Based on our experience, observation, and capabilities, the first three components are available at WSU and School of Electrical Engineering and Computer Science (EECS). The missing component is the availability of funds to help students cover the cost of attending WSU. This is a vital component, especially because of the high concentration of

low-income, Hispanic-origin students in the counties close to WSU, e.g, south-central Washington. Moreover, as the state's sole land-grant institution, WSU has strong presence in every Washington county and draws its students from a pool that include low-income, first-generation students. Availability of financial support in the form of scholarships enables WSU to increase power engineering enrollment.

Specifically, the objectives of this program are to increase the following, based on the actual numbers in 2012 at WSU:

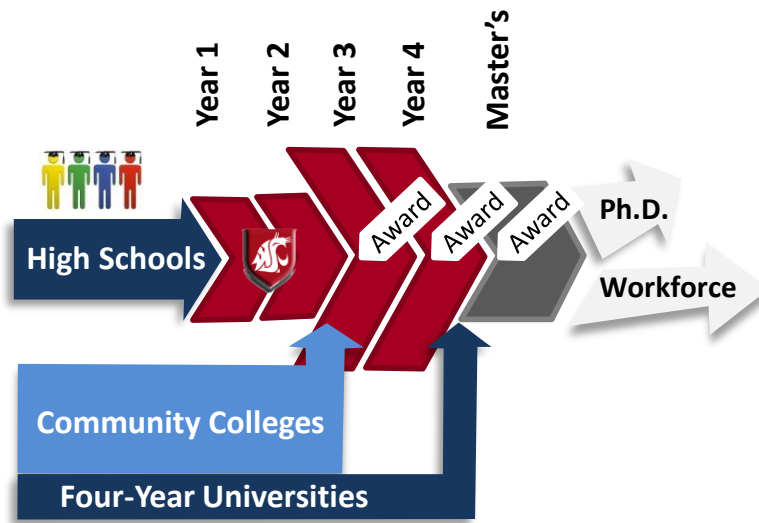
- Number of Bachelor's power engineering major students at WSU by 50%;
- Number of Master's power engineering students at WSU by 50%;
- Number of underrepresented minority power engineering students at WSU by 50%; and
- Number of women power engineering students at WSU by 50%.

This program provides opportunities for lower division WSU students, community college students, and four-year university students interested in power engineering and smart grid [4] to study at WSU in Bachelor's and Master's degrees. WSU already works closely with 20 community colleges Washington that have pre-engineering programs. These community colleges and other four-year universities serve as feeders of our undergraduate and graduate programs. This program builds on existing support structures in the College of Engineering and Architecture and offers opportunities such as a bridge program, faculty and industry mentorship, tutors, study groups, internships, field trips, and a hallmark annual poster event. The program is supported by an industry advisory board consisting of major power companies in Washington that provides mentors and internships opportunities and support our recruitment and retention activities. The program includes a significant evaluation component to assess its impacts on students, industry, community, and WSU.

We build on existing support structures such as a bridge program, faculty and industry mentorship, tutors, study groups, internships, field trips, and a hallmark annual poster event, all supported by an industry advisory board consisting of major power companies that provide mentors and internships opportunities and support our recruitment and retention activities. During the first four years of this program, we offered about \$435,000 in scholarships averaging \$7,000, using funds from our National Science Foundation grant entitled "scholarships for future leaders in electric energy and smart grid." We discuss the recruitment mechanisms in place (advertising strategies, community college visits, and class visits), activities (practicum, research projects, and field trips), application procedure, and the impact of these scholarships in enabling students continue their studies with a higher quality. Our evaluation results via midterm and exit surveys have indicated the significant positive impact these NSF scholarships have had on the students' grades, life balance, and even the ability to stay in school.

## **Scholarship Program**

Fig. 1 shows an overview of our recruiting strategy. Students pursuing the Bachelor's degree with an emphasis in electric energy and the smart grid are recruited from one of the two groups. The



**Figure 1.** Academic pathways with the scholarship program.

first (approximately half of the students) are electrical students at WSU who are entering their junior year and ready to declare an interest. Scholarships are used to recruit some of these students into the power engineering field. The other group is students in pre-engineering programs at community colleges throughout the State of Washington. These students are recruited through a seamless transfer program built on the statewide Associate of Science (Transfer) degree. WSU works closely with approximately 20 community colleges in the State of Washington that have pre-engineering programs including Highline, Walla Walla, Columbia Basin, Big Bend, Yakima Valley, and Wenatchee. Currently, all 20 programs are visited at least once per year by staff of the Dean's office. In addition, there are biannual meetings of the Washington Council on Engineering and Related Technical Education (WCERTE) at which community college and baccalaureate faculty work on transfer issues. As a result of these activities, WSU regularly transfers 250–300 students into its engineering programs each year. Recruiting into the Master's program is from student completing Bachelor's degrees at WSU as well as from undergraduate-degree (four-year) universities in Washington, including Seattle University, Eastern Washington University, and Gonzaga University.

In summary, the program includes three tracks:

- Electrical Engineering students at WSU entering their junior year;
- Students from community colleges transferring to WSU to complete the Bachelor's program in electric energy and smart grid. They may further pursue a Master's degree at WSU; and
- Students from four-year institutions joining WSU to pursue a Master's degree in electric energy and smart grid.



**Figure 2.** Industry advisory board members across the State of Washington.

## Industry Advisory Board

We have established an Industry Advisory Board (IAB) for this scholarship program. The role of IAB is to guide the program to ensure that it has a high level of visibility in the broader community, which is important for recruitment and retention of students. WSU has established strong collaborations with power utilities and manufacturers in the Pacific Northwest. As shown in Fig. 2, we have received strong support from Alstom, Avista, Pacific Northwest Laboratory, Puget Sound Energy, and Tacoma Power. These entities are either already members or considering becoming members of the Center or the Power Engineering Partnership (PEP) program. Through the IAB, we have had strong support for the following:

- Internship opportunities for the scholarship recipients;
- Industry mentors for the scholarship recipients;
- Recruitment and retention of the scholarship recipients; and
- Inputs to power engineering education at WSU.

Board members also serve as spokespersons for the program. The IAB helps ensure that scholarship recipients are well mentored by industry (in addition to the faculty) and that they have internship opportunities. Outreach events for recruitment and retention of highly qualified students are organized with support from the IAB.

## Student Selection Process and Criteria

The program is advertised to local WSU students as well as allied community colleges and local universities through our established communication means, e.g., WSU outreach and our representatives and recruiters at these colleges. The scholarships are offered to students based on

TABLE I. STUDENT SELECTION RUBRIC

Category	Criteria	Documents
Citizenship status	As indicated by NSF; must be met to be eligible for the award	<ul style="list-style-type: none"> <li>• Appropriate immigration documents</li> </ul>
Academic merit	<ul style="list-style-type: none"> <li>• <b>35%:</b> ACADEMIC ACCOMPLISHMENTS: grades and GPA in previous courses</li> <li>• <b>35%:</b> PROFESSIONAL EXPERIENCE: internships, volunteer activities, summer work, student club and professional organization activities, and letter of intent</li> <li>• <b>30%:</b> LETTERS OF RECOMMENDATION: from employers/teachers discussing the potential for professional success, e.g., overcoming economic and social disadvantages, motivation, and communication skills</li> </ul>	<ul style="list-style-type: none"> <li>• Letters of recommendation</li> <li>• Letter of intent</li> <li>• Resume</li> <li>• Transcripts from prior universities and/or community colleges</li> </ul>
Financial need	Determines the amount of award subject to a maximum of \$10,000	<ul style="list-style-type: none"> <li>• Federal financial aid forms (FAFSA)</li> </ul>

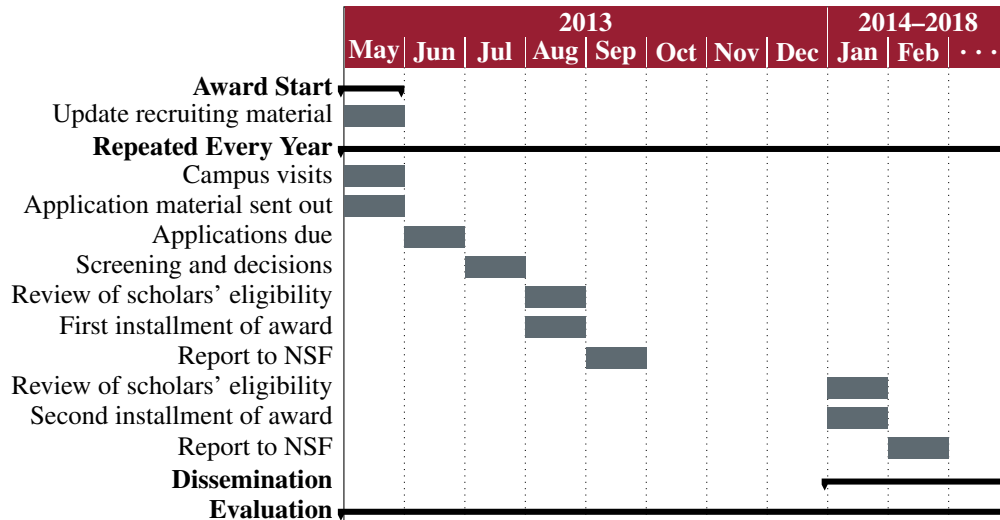
their both merit and need. We follow the NSF guidelines in our selection of the recipients. Therefore, the eligibility criteria of the scholarship recipients include the following:

- Be a U.S. Citizen, National of the United States, alien admitted as refugees, or alien lawfully admitted to the United States for permanent residence.
- Have a demonstrated financial need, defined for undergraduate students by the U.S. Department of Education rules for need-based Federal financial aid Free Application for Federal Student Aid (FAFSA), or, for graduate students, defined as financial eligibility for Graduate Assistance in Areas of National Need (GAANN).
- Demonstrate academic potential as evident by academic achievements, previous work and experience, letters of recommendation, and letters of intent.

Each scholarship has a maximum value of \$10,000 (average award size is expected to be \$6000), with the actual award depending on the “remaining need” demonstrated by FAFSA after the expected contribution from the student family is taken into account.

Table I shows the rubric developed to consistently and fairly judge the academic potential and preparedness of students while recognizing their diverse background and career goals. This rubric includes multiple indicators to gauge both academic merit and professionalism of students. On the academic side, it includes transcripts and resume. On the professionalism side, the rubric includes motivation, time management ability, communication skills as gauged by the letters of recommendation and letters of intent. The same table also shows the documents required to apply for the scholarship program.

Students in the program must maintain their S-STEM eligibility criteria for every semester in the



**Figure 3.** Program timeline.

program. The students who lose their status are replaced with new students. Fig. 3 shows the program timeline. The awards are dispersed as one-half increments at the beginning of each semester provided students are enrolled full-time and remain in good academic standing. S-STEM awards may be provided for up to two years for undergraduate students (junior and senior years), and for one year for Master's students, provided the recipients demonstrate eligibility for a continued award. Scholarships do not continue past the awarding of a degree.

### **Program Components**

**Leveraged Activities** The program builds on the existing support structures available in the WSU Voiland College of Engineering and Architecture as well as similar programs (e.g., CSEMS awarded previously). A number of activities have been established over the past years that are designed to make WSU students more successful. One is a Bridge program (funded in part by the NSF PNW LSAMP program) to ease the transition to WSU for women and underrepresented minority students. Another is the very popular Study/Tutoring Center where tutors are available to assist students in their classes and facilities are provided for them to be able to study together in groups. Another is the Team Mentoring Program that is designed to provide mentors to underrepresented sophomore and new transfer students who are making the transition into the professional part of the engineering program. This program serves approximately 100 students per year. In addition, WSU has established a number of activities to complement the engineering curriculum with relevant out-of-class experiences. These include one credit courses in the engineering shop and the design, construction, and manufacture of electronic circuits as well as week-long courses at industry sites during school breaks. In the last category, WSU is been offering a very successful week-long experiences at power company sites during the spring break. Students who participate in these opportunities often receive offers of summer internships and later, offers of permanent employment. These activities form the basis of the support services of this scholarship program.

***Student Support Services and Programs for Scholars*** Building on the aforementioned activities, we provide students who plan study at WSU with mentoring and advising support. Faculty from the Energy Systems Innovation Center (ESIC) provide mentorship to the scholarship recipients through regular meetings. Academic advising is provided to these students, and they are offered the opportunity to take part in the Center's multidisciplinary research. Through the Center's extensive contact with the industry, it acts as a catalyst for job placement of students and/or internships. Our industry advisory board (IAB) has been instrumental in both mentorship and facilitation of student career placement in the STEM fields. Such efforts contribute to inducing a sense of community among the scholars.

This scholarship program also provides academic support services such as tutoring and study groups to the students. Moreover, the School of EECS has committed one teaching assistant per year for the duration of the program to help provide such support services. We also arrange field trips for our scholarship recipients; WSU Pullman campus is surrounded by smart grid projects, e.g., the DOE-funded Pullman smart city project (in town), a new wind facility (on Highway 195, within 30 minutes), and a hydro generation facility (Lower Granite dam on Snake River, within 45 minutes).

## **Results and Conclusions**

The funds made available through an NSF S-STEM grant under this project are used to make a total of 59 awards, out of which 9 are awarded to women. The approximate average award value so far has been \$7,400. Table II summarizes the relevant information. Compared to 2012 with 60 students in power track, we currently have 80 students, which shows a 33% growth.

The list below includes some of the testimonials provided by the student awardees about the impact of this award on them:

- “Support from the STEM scholarship has made a tremendous difference for my education, especially because I am an out-of-state student. The scholarship has allowed me to concentrate on my classes, reduce work hours, and minimize loans. The scholarship has had a huge, positive impact.” —WS
- “The scholarship has improved my financial situation significantly which has had a positive impact on my stress levels. The additional resources from mentors and the practicum have been invaluable for my development and understanding the power field.” —JZ
- “I feel that one of the greatest benefits of this scholarship comes from the close ties the ESIC has with industry, allowing opportunities for hands on experience such as the Spring Power Practicum.” —NE
- “This scholarship affected me in a very positive way, besides the accompanied financial support which I do appreciate; it boosted my grade and moral, and built my academic confidence. This scholarship boosted my grade noticeably. Although, I never fall class before, it was a concerning issue to eliminate lower letter of C+ from my grade in every semester. Fortunately, right after I was awarded with the ESI scholarship, B” was the lowest grade I had on that semester. Moreover, I used to struggle with twelve to fifteen credits per



TABLE II. AWARDS MADE UNDER THIS PROJECT

Year	Awards		Awards	
	Total	Females	Total	Average
2014	5	2	\$35,171	\$7,036
2014-2015	12	3	\$83,976	\$6,998
2015-2016	17	2	\$131,131	\$7,714
2016-2017	25	2	\$185,957	\$7,438
Total	59	9	\$436,246	\$7,394

semester before this scholarship, but then I started taking more and more credits per semester, whereby I am taking twenty one credits this semester, and I do feel that it is doable. I feel that the ESI Scholarship effect was more of a psychological than physical. It made me feel more comfortable and capable to overcome the school challenges. And I do appreciate the financial support I received.” —AO

## References

- [1] “2007 long-term reliability assessment,” North American Electric Reliability Corporation (NERC), Princeton, NJ, Oct. 2007. [Online]. Available: <http://www.nerc.com/files/LTRA2007.pdf>
- [2] “National science foundation workshop on the future power engineering workforce,” Arlington, VA, Nov. 29–30, 2007. [Online]. Available: <http://ecpe.ece.iastate.edu/nsfws>
- [3] “Preparing the U.S. foundation for future electric energy systems: A strong power and energy engineering workforce,” U.S. Power and Energy Engineering Workforce Collaborative, Apr. 2009. [Online]. Available: [http://www.ieee-pes.org/images/pdf/US\\_Power\\_&\\_Energy\\_Collaborative\\_Action\\_Plan\\_April\\_2009\\_Adobe72.pdf](http://www.ieee-pes.org/images/pdf/US_Power_&_Energy_Collaborative_Action_Plan_April_2009_Adobe72.pdf)
- [4] “Smart grid investment grant program progress report,” U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, Jul. 2012. [Online]. Available: [http://www.smartgrid.gov/document/smart\\_grid\\_investment\\_grant\\_progress\\_report](http://www.smartgrid.gov/document/smart_grid_investment_grant_progress_report)