

## ***How2Power's ECCE 2016 Post Conference Report: Well Planned Program Made The Most Of Papers And People***

*by David G. Morrison, Editor, How2Power.com*

This year's [IEEE Energy Conversion Congress and Expo \(ECCE 2016\)](#), held September 18-22, drew a record crowd of over 1600 attendees to the Wisconsin Center in downtown Milwaukee, Wisconsin. This level of participation brought a special energy to the event, which was palpable in the many lively sessions, the busy expo, and several popular social events that were spread across the conference program. These sessions brought together friends and colleagues, while providing opportunities for attendees to meet others in their field.

In the case of the awards banquet, it was both an opportunity to relax at the end of a hectic week and a chance to recognize the lifelong contributions of this year's winners of coveted IEEE prizes such as the Nikola Tesla Award and the William E. Newell Power Electronics Award among others. On a different level, but still important, the conference also recognized some of the interesting work done recently in power electronics and machines with its presentation of the ECCE best paper awards. Information on these awards is provided here.

With the many hundreds of presentations given at ECCE, analyzing or summarizing the content can be a challenging activity. It's likely that each attendee walks away with a unique perspective on the conference. However, each year new themes emerge to receive special attention. This year, the industrial Internet of Things and cybersecurity appear to be two such themes and in this article I have briefly highlighted how the program addressed these issues.

Of course, identifying one or two new themes does not do justice to a conference program that is so broad and deep in content. In this regard, it is helpful to turn to the analysis that conference chair John Shen and technical program chair Robert Balog presented at the beginning of the plenary session. The data they have provided about the scope of the program as well as the attendee profile convey more of the big picture of the conference's scope, depth and appeal.

### ***Festive Social Gatherings Throughout the Program***

A Sunday night, "Meet and Greet" reception at the elegant Milwaukee Art museum, opened the conference and set the tone for what would be a week's worth of networking opportunities for students, instructors, engineers and executives. On Monday evening, attendees poured into the ECCE expo for food and drink and their first look at the exhibits.

Later that night, the Harley-Davidson museum was the setting for a lively Committee Appreciation Dinner, recognizing the efforts of the many who volunteered their time to organize ECCE, while offering a unique opportunity to see and experience Harley-Davidson's iconic products and history.



*Fun at the Harley-Davidson museum.*



*Conference goers enjoy ECCE 2016's opening reception at the Milwaukee Art Museum.*

While this event was just for the conference planners and organizers, earlier that day attendees were able to take factory tours of the facility where H-D's engines and transmissions are built. These tours were sold out.

Social activities culminated in Wednesday night’s ECCE banquet, an Oktoberfest party, which drew on Milwaukee’s German heritage to host one of the more festive conference banquets I can recall. ECCE Oktoberfest featured musicians and dancers in traditional costumes entertaining partygoers as they lined up to partake of hot pretzels and brats, freshly carved meats, and freely flowing beer—served in souvenir ECCE glass steins. Seats at the tables were sometimes in short supply, partly because few were in a hurry to leave!



Scenes from ECCE 2016’s Oktoberfest party.

A final social gathering was held on Thursday—the annual awards luncheon. I have to admit, I have not stuck around for this luncheon in the past. But I was glad I did this time. In addition to the delicious meal and friendly company, attendees witnessed the presentation of several notable awards by the two IEEE societies that sponsor ECCE—the Power Electronics Society (PELS) and the Industry Applications Society (IAS). At this event, Bruno Lequesne of E-Motors Consulting was presented with the 2016 IEEE Nikola Tesla Award “for contributions to the design and analysis of actuators, sensors, and motors for automotive applications.”

Lequesne is credited with “advances leading to the realization of “more electric automobiles” that use electrical and electromechanical systems for improved fuel economy, reduced greenhouse emissions, and better safety. Earlier that same morning, I had had the pleasure of hearing Lequesne’s talk on “Automotive Motors: Recent Accomplishments and Challenges Ahead” in first session in Advanced Electrical Machines.



Bruno Lequesne receives the 2016 IEEE Nikola Tesla Award.



Johann W. Kolar receives the 2016 IEEE William E. Newell Power Electronics Award.

Also honored was Johann W. Kolar, a professor at ETH Zurich, who received the 2016 IEEE William E. Newell Power Electronics Award “for contributions to the advancement of three-phase pulse-width modulation (PWM) converter systems and power electronics education.” Over three decades, Kolar “has driven advances in three-phase PWM rectifier and matrix converter technology, including the Vienna Rectifier and the Sparse Matrix converter.” In addition, Kolar is credited with “a revolutionary new approach for education in power electronics” that has taken root in academia and industry around the globe.

Among the other very appreciative honorees were Seung-Ki Sul who received the IAS Outstanding Achievement Award; Mark Dehong Xu, who received the PELS R. David Middlebrook Achievement Award; Dr. Jih-Sheng (Jason) Lai who received the IAS Power Conversion Systems Dept. Gerald Kliman Innovator Award; and Huai

Wang who received the Richard M. Bass Outstanding Young Power Electronics Engineer Award, for his contributions to the reliability of power electronic conversion systems.

And finally, the IEEE PELS recognized CPES' Dushan Boroyevich with its Harry A. Owen, Jr. Distinguished Service Award "for distinguished volunteer service, vision and leadership in guiding the global expansion of the Power Electronics Society and for his skills as a unique communicator, society advocate, mentor and scientist." I encourage you to read the interesting bios posted for these very deserving individuals. Copies of those bios from the awards ceremony program along with the names of the IEEE Fellows who were elevated this year by PELS and IAS will be posted soon on How2Power's [ECCE page](#).

While I have specifically highlighted ECCE's designated social activities, which provided networking opportunities in a fun and relaxed setting, I would like to note that there were many other chances to meet with colleagues and friends within the context of the conference program. Attendees were kept well hydrated (and caffeinated) at numerous coffee breaks.

### **ECCE 2016's Best Papers Recognized**

Each year, ECCE recognizes a limited number of outstanding papers that were presented at the conference. These papers provide insights into the subjects and issues that are driving research in the power electronics and electrical machine fields, as well as where some of the most exciting work is being performed.

According to Robert Balog, the best paper awards were given out at the conference with the author teams each receiving a \$100 amazon gift card and a printed certificate. The titles of the winning papers and their authors were posted to the conference's electronic bill boards every morning and afternoon session. But until now, these papers have not been announced publicly. Here then is a list of all of the Best Paper award winners at ECCE 2016.

#### **Monday, September 19, 2016 Sessions**

- **Oliver Knecht**—*Comparative Evaluation of a Triangular Current Mode (TCM) and Clamp-Switch TCM DC-DC Boost Converter*
- **Dong Jiang and Zewei Shen**—*Paralleled Inverters with Zero Common-Mode Voltage*
- **Ying Huang, Chun-Yuen Lai, Song Xiong, Siew-Chong Tan and Shu Yuen (Ron) Hui**—*Non-Isolated High-Step-Up Resonant DC-DC Converter*
- **Cristian Blanco, Francesco Tardelli, David Diaz, Pericle Zanchetta and Fernando Briz**—*Design of a Cooperative Voltage Harmonic Compensation Strategy for Islanded Microgrids Combining Virtual Admittances and Repetitive Controllers*
- **Christophe Cyusa, Simba and Yasutaka Fujimoto**—*Pre-Drive Test of an Implemented Novel Radial-Gap Helical ROTLIN Machine*
- **Ping-Heng Wu, Yuh-Tyng Chen and Po-Tai Cheng**—*The Delta-Connected Cascaded H-Bridge Converter Application in Distributed Energy Resources and Fault Ride Through Capability Analysis*

#### **Tuesday, September 20, 2016 Sessions**

- **Harry C.P. Dymond**—*Reduction of oscillations in a GaN Bridge Leg Using Active Gate Driving with sub-ns Resolution Arbitrary Gate-Impedance Patterns*
- **Faizul Momen, Khwaja Rahman, Yochan Son, Bonho Bae and Peter Savagian**—*Electrical Propulsion System Design of Chevrolet Bolt Battery Electric Vehicle*
- **Xu She, Rajib Datta, Maja Harfman Todorovic, Gary Mandrusiak, Jian Dai, Tony Frangieh, Philip Cioffi, Brian Rowden and Frank Mueller**—*High Performance SiC Power Block for Industry Applications*

- **Nicola Bianchi, Alessandro Castagnini, Giulio Secondo and Pietro Savio Termini**—*Replacing SPM by PMARel Machines in Low-speed Hightorque Applications*
- **Dheeraj Bobba, Gerd Bramerdorfer, Yingjie Li, Timothy A. Burress and Bulent Sarlioglu**—*Stator Tooth and Rotor Pole Shaping for Low Pole Flux Switching Permanent Magnet Machines to Reduce Even Order Harmonics in Flux linkage*
- **Dennis Karwatzki and Axel Mertens**—*Control Approach for a Class of Modular Multilevel Converter Topologies*
- **Hironori Nagasaki, Pin-Yu Huang and Toshihisa Shimizu**—*Characterization of Power Capacitors on Practical Current Condition Using Capacitor Loss Analyzer*
- **Amol Deshpande and Fang Luo**—*Comprehensive Evaluation of a Silicon-WBG Hybrid Switch*
- **Chang Peng, Landon Mackey, Iqbal Husain, Alex Huang, Bruno Lequesne and Roger Briggs**—*Active Damping of Ultra-fast Mechanical Switches for Hybrid AC and DC Circuit Breakers*
- **Mahshid Amirabadi**—*Cuk-Based Universal Converters in Discontinuous Conduction Mode of Operation*
- **Ashraf Said Atalla, Mohammed Agamy, Mark Dame, Liwei Hao, Gary Dwayne Mandrusiak, Konrad Weeber and Yan Pan**—*Advancements in High Power High Frequency Transformer Design for Resonant Converter Circuits*

#### Student Demonstration Winners

- **1<sup>st</sup> prize** - High Power Density Impedance Control Network DC-DC Converter Utilizing an Integrated Magnetic Structure.
- **Student: Ashish Kumar, University of Colorado-Boulder.** Advisor: Khurram Afridi
- **2<sup>nd</sup> prize** - Dynamic Matching System for Radio-Frequency Plasma Generation.
- **Student: Anas Al Bastami, Massachusetts Institute of Technology.** Advisor: David Perreault
- **3<sup>rd</sup> prize** - A 3D printed Fluid Filled Variable Elastance Electrostatic Machine Optimized with Conformal Mapping.

**Students: Baoyun Ge, Aditya Ghule, University of Wisconsin-Madison.** Advisor: Dan Ludois

#### Wednesday, September 21, 2016 sessions

- **Kent Inoue**—*Reduction on Radiation Noise Level for Inductive Power Transfer Systems with Spread Spectrum focusing on Combined Impedance of Coils and Capacitors*
- **Tom Cox**—*Vehicular Suspension and Propulsion Using Double Sided Linear Induction Machines*
- **Zitao Liao**—*A GaN-based Flying-Capacitor Multilevel Boost Converter for High Step-up Conversion*
- **Wooyoung Choi**—*New Configuration of Multi-Functional Grid-Connected Inverter to Improve Both Current-Based and Voltage-Based Power Quality*

#### Thursday, September 22, 2016 sessions

- **Maksim Sokolov**—*State-Space Flux-Linkage Control of Bearingless Synchronous Reluctance Motors*
- **Vandana Rallabandi**—*On the Feasibility of Carbon Nanotube Windings for Electrical Machines – Case Study for a Coreless Axial Flux Motor*

- **Shih-Chin Yang**—High Speed Operation of Permanent Magnet Machine Position Sensorless Drive Using Discretized EMF Estimator

## IoT And Cyber Security Came To The Fore

As in past years, this conference touched on many familiar topics in power electronics, drives and electric machine design with much attention to applications in renewable energy, electric and hybrid electric vehicles, and smart grid and utility applications. However, this year, we also saw the emergence of timely topics such as the Internet of Things (IoT), which was addressed in a plenary talk by Blake Moret, president and CEO of Rockwell Automation, and in a town hall meeting. At ECCE, the subject of IoT is viewed through the prism of industrial uses, hence it is referred to as the industrial IoT.

In his talk on “Intelligent Motor Control In the Connected Enterprise,” Moret pointed to the global demand for resources—water, raw materials, and energy—and the need to use those resources efficiently as a driver behind the industrial IoT. “That productivity, that need to be able to take those resources and to be able to do more with less is going to be the subject of an estimated one trillion dollars worth’ of investment as we find ways to drive productivity into the conversion of those resources into finished goods.”

At the same time, “tremendous amounts of data ... are spun off as a natural byproduct of control processes,” creating another reason for bringing connectivity into industrial processes. He also noted that only about 14% of machinery in the U.S. today is connected and the percentage is even lower in the “emerging economies” around the globe. “So there’s a huge opportunity to get benefits from

greater connectivity.” Industrial IoT was also the subject of a Townhall meeting.

The theme of connectivity also surfaced in another very interesting plenary talk, Massoud Amin’s “Future of the Smart Grid.” Amin is a professor of electrical and computer engineering at the University of Minnesota, and holds other titles.

However, when plenary chair Iqbal Husain introduced Amin as the “father of the Smart Grid,” it immediately became apparent that Amin is uniquely qualified to discuss this subject and indeed his presentation did not disappoint as he discussed in detail the “profound change” that is sweeping the electric industry as it seeks to implement smart grid technology and how smart grid technology will affect so many different aspects of modern life.



*“Father of the Smart Grid,” Massoud Amin analyzes the changes sweeping the electric industry in his plenary on the “Future of the Smart Grid.”*

At the heart of the matter, as Amin explained, “Electricity is no longer just providing electrons...it’s about services, quality of life and whatever the 21<sup>st</sup> century—beyond our comprehension perhaps—is going to power. So we are talking about a more perfect supply, more perfect delivery, and more perfect use.” Amin’s talk served not only to define what the smart grid is meant to be, but its challenges and implications for engineers and society. I strongly recommend reading the slides from Amin’s talk as well as the other plenaries, which are now available [online](#).

Another subject which emerged at this year’s ECCE was “Cyber Security of the Grid” which was addressed in two special sessions on Wednesday. This session included talks by representatives from a several stakeholders in this field including the U.S. Dept. of Energy, ABB, the Cyber Resilient Energy Delivery Consortium, Florida International University, and Schweitzer Engineering Laboratories, Cisco Systems, Carnegie Mellon University, and Oak Ridge National Laboratory. If like me you were not able to attend these sessions, you may be pleased to learn that these presentations are all posted [online](#).

Another new topic for this year’s special sessions was the “Water Energy Nexus”. This is not a subject that’s caught on widely like IoT or cybersecurity. Nor can I recall it being discussed before at ECCE or other power electronics conferences.

Perhaps for that reason, the session on Wednesday was not heavily attended. However, sitting in on these presentations, I must say they were fascinating. The talks addressed two important subjects that we are likely to hear more about in the future. One is the use of water in energy generation. Another is the use of electricity in the treatment and delivery of water.



*In his opening plenary talk, Blake Moret discussed the importance of the industrial Internet of Things.*

On the first topic, Johan Enslin of Duke Energy spoke on "Waste Water Treatment and Hydro-Power Technologies." One of the amazing takeaways from Enslin's talk is that "power generation is the largest consumer of water." In addition, he explained how power electronics and fuel cells are needed to oxidize bromine as part of the fracking process.

Meanwhile, a talk on "Low Energy Consumption Waste Water Treatment Systems," Kevin Shafer of MMSD explained how energy intensive water treatment plants are and highlighted opportunities for saving energy in these systems, which are unseen yet so critical to our daily lives. Similarly, a presentation by Junhong Chen of UW Madison on "Real-Time Water Sensors in Intelligent Water Distribution Systems" introduced the subject of intelligent water systems and the electronic techniques used to sense E-coli in the water.

Likely the location of this year's conference inspired this session as the conference program notes that "Milwaukee is fast becoming a center for research and development in the water-energy area" through the leadership of local universities, civic and industrial organizations and companies. But as water and energy are global issues, I think we can expect to hear more talks related to the water energy nexus at future IEEE conferences.

Along with the new subject matter, it's to be expected that every power electronics conference today features many talks on wide-bandgap power semiconductors. With its higher power focus, this tends to mean more emphasis on silicon carbide (SiC) and in addition to the many paper sessions dealing with SiC, there was a special session on "Practical Implementation of SiC MOSFETs for Industrial Applications."

As with some of the other special sessions, these talks tended to be more practical and commercial in nature with representatives from Infineon, GE, and ABB discussing the development of SiC MOSFETs and MOSFET modules. This session was well attended as most wide-bandgap sessions tend to be these days. Of course, there were also talks on GaN devices in the papers sessions and at least two GaN semiconductor suppliers in the exhibition.

I have not really addressed the electric machine sessions as this newsletter focuses on power electronics. However, the ECCE program is rich with papers and presentations on motors and generators for a range of applications, and the combination of power electronics and machines in the program is one of the key features that distinguishes ECCE from other conferences.

### Attendee And Technical Program Stats



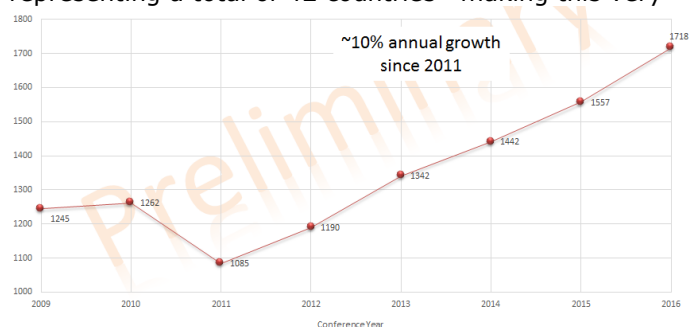
Technical program committee chair Robert Balog addresses plenary session audience accompanied by co-chairs Maryam Saeedfard and Avoki Omekanda.

Having discussed some of the program highlights that I observed, I think it's also worthwhile to present a higher level view of the technical program. For this I turn to data provided by ECCE 2016's technical program chair, Robert Balog and conference chair John Shen. However, before delving into the topics addressed at ECCE, it's interesting to look at some of the data on attendees.

As Shen observed at the start of the plenary, almost 50% of the participants came from North America, around 30% from Asia, and nearly 20% from Europe—representing a total of 42 countries—making this very much an International conference. Shen observed that this year's attendees collectively

traveled roughly 8 million km to be part of the goings on in Milwaukee. That's roughly ten trips to the moon, he quipped.

Of course drawing them to Milwaukee was a bigger than ever conference program. This year's technical program encompassed nine oral sessions spread across 16 parallel tracks, for a total of 640 papers (which is 10% higher than last year's program in Montreal.) The 16 tracks has its pluses and



Digest submissions to ECCE have been growing steadily over the past five years. A total of 640 papers were accepted for the oral sessions and another 285 papers for the poster sessions. The technical program committee considers all papers "to be of equal quality."

minuses—there are so many papers and sessions to choose from, but you can only be in one session at a time. However, this challenge is not unique to ECCE.

Additionally, the technical program included three poster sessions with a total of 285 papers. Balog noted that it is the policy of ECCE’s technical program committee, “that all papers are considered to be of equal quality, regardless of oral or poster delivery format. As a way to underscore our view, more of the awards will be given to poster papers than oral papers.” Balog added that “as the conference continues to grow, we expect that the poster sessions will continue to gain predominance going forward.”

On top of the oral paper sessions and poster sessions, the technical program also included town hall forums, student project demos and special sessions in which representatives from industry give presentations.

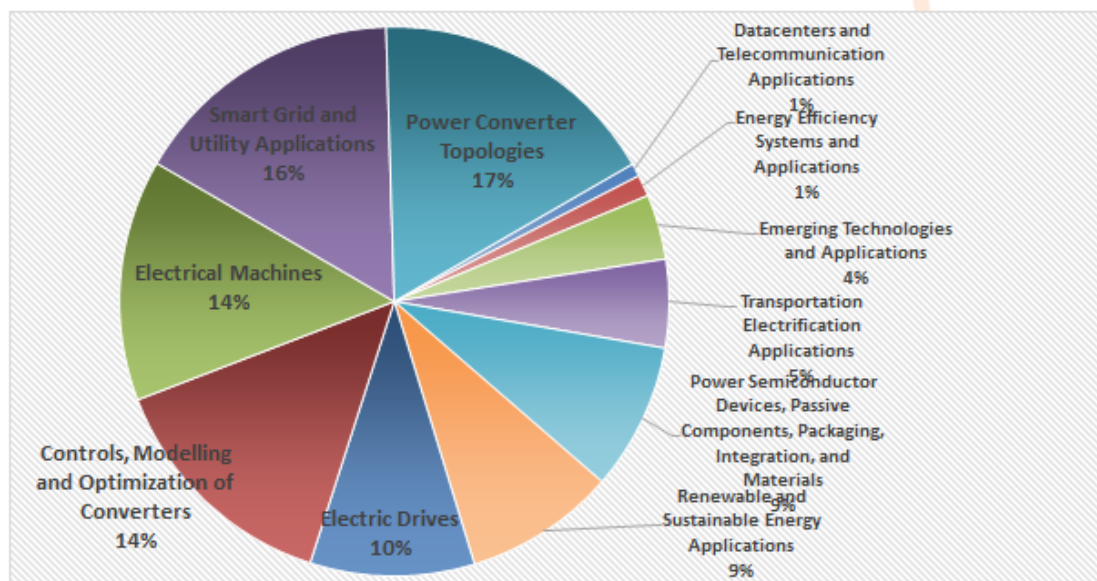
Of course, these are just numbers, to get a true sense of the conference, we need to look at topics. Balog explained that the ECCE sessions and papers can be categorized within two major tracks: 1) those with a systems and applications focus and 2) those with a core technologies focus. The following list gives the breakdown.

Systems and Applications Focus:

- Renewable and sustainable energy applications
- Smart grid and utility applications
- Datacenters and telecom applications
- Transportation electrification applications
- Energy efficiency systems and applications
- Emerging applications

Core Technologies focus

- Power converter topologies
- Controls, modeling and optimization
- Electrical drives
- Electrical machines
- Components, packaging, integration, and materials.



ECCE 2016 track popularity based on digest submissions.



*ECCE 2016 conference chair John Shen offers opening remarks in the plenary session.*

In discussing ECCE 2016, I would be remiss if I did not single out this year's conference chair, John Shen. Shen's tireless leadership and enthusiasm were felt throughout the program, as he addressed the participants in the plenary session and many other events. It was clear that John's goal was to make this event both as productive and enjoyable as possible for all attendees.

In that regards, this was a year-long, group effort in which he was joined by an army of volunteers that included three chairs, 24 vice chairs, 132 topic chairs along with 2,417 reviewers—who collectively put in untold hours to produce what was hailed as another successful ECCE conference.

As in past years, the planning for ECCE 2016, which actually spanned a multiple year cycle as such large conferences usually do, was supported by the skilled conference management professionals at Courtesy Associates.

In his post-conference remarks Shen thanked these and other participants.

"I would like to express my utmost gratitude to the members of the organizing committee, the technical program committee, the steering committee, and Courtesy Associates, who with hard work and selfless dedication have made possible this event. I would like to thank PELS and IAS for their sponsorship and stewardship, and the generous support of our Platinum, Gold, and Silver corporate sponsors. I would like to thank each and every one of you as a presenter, an attendee, an exhibitor, a volunteer, or any combined role of the above for your contribution and participation," said Shen.