SGRE19

2nd International Conference on Smart Grid and Renewable Energy

CONFERENCE PROGRAM

19 - 21 November 2019
Doha, Qatar

www.sgre-qa.org

TEXAS A&M UNIVERSITY *at* QATAR · KAHRAMAA · Qatar National Research Fund — Member of Qatar Foundation

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SGRE 2019 Program: Contents

Message From the SGRE-2019 Conference Chairs

On behalf of the organizing committee, it is our pleasure to welcome all the delegates, representatives of various universities, research institutes, industries and participants from all around the world to the Second Conference on Smart Grid and Renewable Energy (SGRE2019), 19-21 November 2019, in Doha, Qatar.

Looking at the importance of the smart grid and renewable energy resources integration for the world, this conference will explore the viability of this advanced technology. This conference brings together leading scientists, researchers and stakeholders from international and national research institutions, universities and industry to exchange information on medium- to long-term research and future challenges of power electronics, smart grid and renewable energies. Therefore, attendees will engage in discussions of ongoing and future research toward next-generation power electronics, renewable energy technologies and applications, leading to research collaboration opportunities among participants.

The goal of the conference is to generate a long-term smart grid research agenda relating to smart grid and renewable energy. This should lead to a smarter electric grid that is necessary for maintaining rapid economic development, improved social lifestyle and a greener living environment. Furthermore, the conference will generate awareness in the industries, engineers and researchers about advanced smart grid technologies and their benefits; renewable energy resources and their integration with the smart grid and information and communications technologies and their adoption in the smart grid.

We wish you a most pleasant stay in Doha. Qatar is important Middle East country and it is called the pearl of Arab Gulf. You can see the unique harmony of the desert and the sea in this country. It's rare to see a great city in the making these days, but here's your chance.

Finally, we would like to thank all the authors and participants for their input, the Technical Program Committee, the Track Chairs, the Keynote Speakers, the Special Session Organizers, the reviewers, and all the local and international volunteers who have contributed to the event. It is thanks to their hard work that SGRE 2019 is now a reality.

We wish all participants a happy and pleasant stay in Doha.

H.E. Eng. Essa Bin Hilal Al-Kuwari
Honorary Chair

Haitham Abu-Rub
General Chair

Sertac Bayhan
General Co-chair

Mariusz Malinowski
General Co-chair

Message From the SGRE 2019 Technical Program Chairs

Welcome to Doha, Qatar and thank you very much for contributing with your work to the second Conference on Smart Grid and Renewable Energy (SGRE2019). We hope that the conference will be a great success as a social and professional interaction event and, most importantly, from the technical content point of view.

Not only is Qatar the richest country in the world, enjoying the highest GDP per capita worldwide, Qatar has also taken major initiatives to achieve its 2030 national vision, which is to establish a knowledge-based economy. To this end, Qatar has established the Qatar Foundation, which fosters a number of key world universities to offer education and research that is equivalent to what is offered on the mother campuses of those universities. Within Qatar Foundation, the Qatar National Research Fund (QNRF) funds cutting-edge research with participants from all over the world. Each year, QNRF invests more than $150 million in research. In terms of infrastructure, Doha is equipped with state-of-the-art facilities. Currently, there are more than 15,000 hotel rooms, and many more will be built in the next few years in preparation for hosting the FIFA World Cup Qatar 2022.

We are proud to tell you that the SGRE 2019 program committee put together an outstanding program, including three keynote speakers, Student and Young Professionals Tutorials and Industry Link featuring four talks given by international and local expert scientists covering all aspects of the conference.

The statistics are already highlighting the success of the conference: 152 papers were submitted, involving more than 500 authors from 20 countries, and 79 were finally accepted for publication. The peer review process has been hard work for track chairs, special sessions organizers and researchers from all over the world who contributed as reviewers. In total, more than 500 reviewers contributed their knowledge to make the best decisions on the papers based on roughly three reviews per paper. We would like to address a special "Thank You" to all of these people who contributed to the SGRE 2019 Technical Program success.

It has been a pleasure for us to be Technical Program Chairs of the conference, and we hope that your participation in SGRE 2019 and your stay in Doha will be fruitful and enjoyable.

Dmitri Vinnikov
Technical Program Chair

Atif Iqbal
Technical Program Co-chair

Hasan Komurcugil
Technical Program Co-chair

Shady Khalil
Technical Program Co-chair

Mohammad Shadmand
Technical Program Co-chair

Conference Committees

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Mohamed Ali Al Muhannadi, Qatar General Electricity and Water Corporation (KAHRAMAA), Qatar
Dalia El Toukhy, Qatar General Electricity and Water Corporation (KAHRAMAA), Qatar

About Qatar

General

Qatar's weekend is Friday and Saturday. Banks are usually open 7:30 to 13:00, though an increasing number of banks are open longer and at weekends. ATMs are found throughout the city, in hotels and all the shopping malls.

Climate

Qatar benefit from year-round sunshine, with temperatures at the beginning of November ranging between 25 °C and 35 °C. The best months to enjoy Qatar's pleasant weather are October to May.

Transportation

Karwa is the national taxi and limousine service. To book a taxi call +974 4458 888. Furhermore, UBER taxi service is available in Qatar. You can also use your international driving licens for seven consecutive days.

Health

As with undertaking any form of travel, adequate insurance is strongly advised. Qatar has excellent medical facilities, both government and private. For emergencies – fire police, or ambulance – call 999.

Tourist Hotspots

Doha Corniche

A waterfront promenade that stretches for the entire length of Doha Bay, the Corniche offers spectacular vistas of the city, from the dramatic high-rise towers of the central business district to the bold shapes of the Museum of Islamic Art.

Souq Waqif

A stroll down the bustling alleys of Souq Waqif provides an authentic taste of traditional commerce, architecture and culture. The maze of small shops offer a dazzling array of Middle Eastern merchandise, from spices and seasonal delicacies such as fresh dates and nuts, to ornate jewellery, clothing, handicrafts and a treasure trove of souvenir bargains.

Museum of Islamic Art

Experience 14 centuries in a few hours at one of the leading collections of Islamic art in the world. The MIA's magnificent and imaginatively presented displays of the finest art and artifacts from across the Islamic world have earned it recognition among the world's top cultural institutions.

Katara Cultural Village

An innovative interpretation of the region's architectural heritage, this purpose-built development's impressive theatres, galleries and performance venues stage a lively year-round programme of concerts, shows and exhibitions.

The Pearl - Qatar
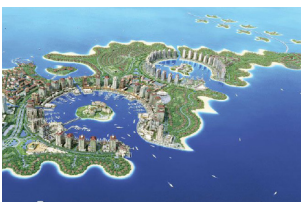
The Pearl Qatar is a man-made island off the West Bay coast featuring Mediterranean-style yacht-lined marinas, upmarket residential towers, villas and internationally renowned hotels, as well as luxury shopping at top brand-name boutiques and showrooms.

Venue: Hilton Doha Hotel

Centrally located in Doha's Diplomatic area, only 30 minutes from Hamad International Airport. Top among hotels in Doha.
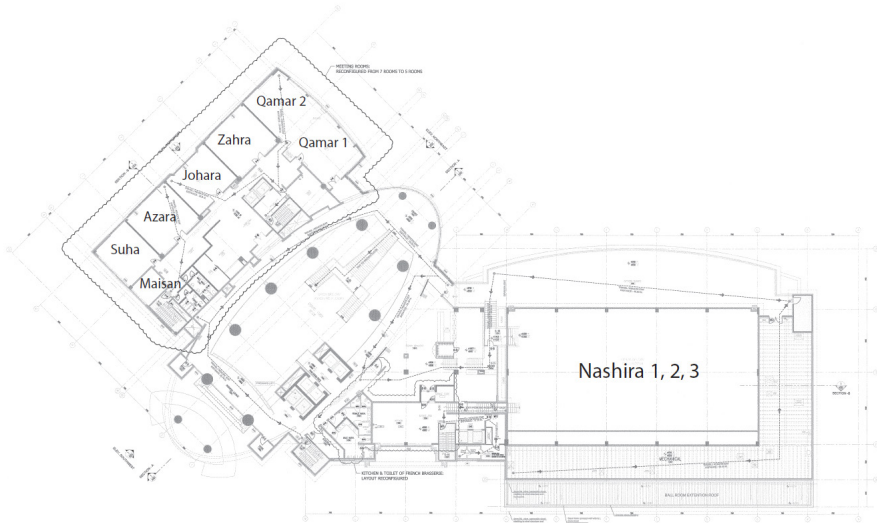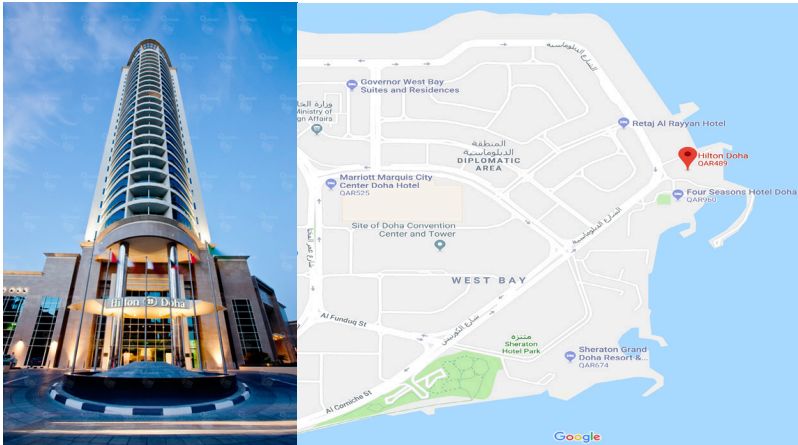
Keynotes: Nashira 1
Student and YP Tutorial and Industry Link: Nashira 1
Parallel Sessions: Nashira 1, Qamar 1 & 2
Exhibition: Nashira Foyer
Breaks: Nashira Foyer
Lunch: Nashira 2

Social Events

Welcome Reception

The welcome reception will be at the Hilton Doha Hotel swimming pool area on 19 November between 19:00 and 21:00.

Gala Dinner & Awards Ceremony

A Gala Dinner and Award Ceremmony will be at the Hilton Doha Hotel - Nashira 2 on 20 November between 19:00 and 21:00.

Texas A&M University at Qatar Tour

A visit to Texas A&M University at Qatar will be 21 November from 14:00 to 16:00. Please register for this tour at the Registration Desk. Because of space limitations, registration will be on a first-come, first-served basis.

KAHRAMAA Awareness Park Tour

A visit to KAHRAMAA Awareness Park will be on 21 November, from 14:00 to 16:30. Please register for this tour at the Registration Desk. Because of space limitations, registration will be on a first-come, first-served basis.

Day One
19 November 2019

07:30-08:30 **Nashira Foyer**	Registration
8:30-9:15 **Nashira 1**	***Opening Ceremony and Remarks*** **Haitham Abu-Rub** Conference General Chair, Texas A&M University at Qatar, Qatar **H. E. Eng. Essa bin Hilal Al-Kuwari** President, Qatar General Electricity and Water Corporation (KAHRAMAA), Chairman of the Arab Union of Electricity, Qatar **César O. Malavé** Dean, Texas A&M University at Qatar, Qatar **Abdul Sattar Al-Taie** Executive Director, Qatar National Research Fund, Qatar
09:15-10:15 **Nashira 1**	***Keynote 1: Solid-state Transformer Applications – A Glimpse Into the Future*** Prof. Johann W. Kolar, ETH Zurich, Switzerland Moderator: Prof. Mariusz Malinowski, Warsaw University of Technology, Poland
10:15-10:45 **Nashira Foyer**	Coffee Break
10:45-12:30 **Nashira 1**	***Power Electronics and Applications 1*** Chairs: Hasan Komurcugil, Yushan Liu **Robust Sliding Mode Controller Design for DC-DC Converters with Adaptive Gains** Abdulrahman Alassi, Mehdi Houchati, Nader Meskin **Predictive Current Control with Synchronous Optimal Pulse Patterns** Jens Onno Krah, Tobias Schmidt, Joachim Holtz

10:45-12:30 **Nashira 1**	**A Switching-gain Controller for Grid-Connected MMC Complying with Voltage Ride-through Requirements** Alaa Altawallbeh, Nader Meskin, Ahmed Massoud **Model Predictive Self-healing Control Scheme for Dual Active Bridge Converter** Mohsen Hosseinzadehtaher, Ahmad Khan, Matthew Baker, Mohammad Shadmand **Fault-tolerant D-STATCOM-based Matrix Converter** Wesam Rohouma, Robert Balog, Aaqib Peerzada, Miroslav Begovic **Seamless Transition Between Dual Operating Modes of A Single-phase Quasi-Z-source Inverter** Xiao Li, Yushan Liu, Yaosuo Xue
10:45-12:30 **Qamar 1**	*Power Generation, Transmission and Distribution 1* Chairs: Lazhar Ben Brahim, Omar Ellabban **Mutual Vehicle-to-Home and Vehicle-to-grid Operation Considering Solar-load Uncertainty** Reza Hemmati, Hasan Mehrjerdi, Nasser A. Alemadi, Elyas Rakhshani **Modeling of Digital Distance Relay in EMTPWorks considering Protective Zones and Trip Characteristics** Amir Ghorbani, Hasan Mehrjerdi, Atif Iqbal **Experimental Study on Overcurrent Relay Setting for Maximum Protection Level** Reza Hemmati, Hasan Mehrjerdi, Atif Iqbal, Elyas Rakhshani **Fast Fault Detection of Synchronous Generators** Mina Mola, Ahmad Afshar, Nader Meskin, Mehdi Karrari **Increasing the Share of Wind Power by Sensitivity Analysis - based Transient Stability Assessment** Nakisa Farrokhseresht, Arjen van der Meer, Jose Reuda Torres, Mart van der Meijden, Peter Palensky

12:30-13:30 **Nashira 2**	Lunch
13:30-14:30 **Nashira 1**	*Keynote 2:* **Model-based Design and Operations of Smart Energy Systems** Prof. Peter Palensky, TU Delft, Netherlands Moderator: Dr. Antonio Sanfilippo, Qatar Environment and Energy Research Institute, Doha, Qatar
14:30-15:00 Nashira Foyer	Coffee Break
15:00-16:30 **Nashira 1**	*Transportation Electrification and Automotive Technologies* Chairs: Sevki Demirbas, Jaroslaw Guzinski **Electric Vehicle Fast Chargers: Futuristic Vision, Market Trends and Requirements** Noon Hussein, Ahmed Massoud **Multimodule ISOP DC-DC Converters for Electric Vehicles Fast Chargers** Mena ElMenshawy, Ahmed Massoud **Real-world Driving Cycle: Case Study Muscat: Performance Analysis** Abdullah Al-Janabi, Nasser Al-Azri, Omar Abu Mohareb, Michael Grimm, Hans-Christian Reuss **Electro-mobility in Oman: Examine the Current Available Infrastructure** Abdullah Al-Janabi, Emad Summed, Mahmood Al-Kindi, Omar Abu Mohareb, Michael Grimm, Hans-Christian Reuss **A Novel High Frequency-Link Bidirectional DC-DC Converter for Electric Vehicle Applications** Oguz Alkul, Sevki Demirbas
15:00-16:30 **Qamar 1**	*Smart Grid Technologies and Applications 1* Chairs: Atif Iqbal, Mohamed Trabelsi **Matlab/Simulink Modeling and Simulation of Electric Appliances Based on their Actual Current Waveforms** Adel Gastli, Serkan Kiranyaz, Ridha Hamila, Omar Ellabban

15:00-16:30 **Qamar 1**	**Design and Field Implementation of Blockchain Based Renewable Energy Trading in Residential Communities** Shivam Saxena, Hany Farag, Aidan Brookson, Hjalmar Turesson, Henry Kim **Novel Home Energy Optimization Technique based on Multi-Zone and Multi-Objective Approach** Kamel Benhmed, Omar Ellabban, Adel Gastli **Multi-Simulation Environment for Smart Grid: Co-simulation Approach** Omid Palizban, Kimmo Kauhaniemi
15:00-16:30 **Qamar 2**	***Renewable Energy and Energy Storage Systems 1*** Chairs: Hadi Kanaan, Samet Biricik **High-Efficiency Cu (In1-xGax) Se2 Solar Cell Investigation with Single Layer Antireflection Coating of MgF2** Nour El Islam Boukortt, Salvatore Patanè **A Newton-Raphson-based Algorithm for Statistical Characterization of Wind Speed Data** Cesar H. Yoshikawa, Thiago A. R. Passarin, Guilherme de S. Peron **Wind Energy DC Nanogrid Dynamic Modelling and MPPT Operation** Maged Bauomy, Haytham Gamal, Adel Shaltout **Wind Data Forecast using Artificial Neural Networks** Felipe Oliveira, Guilherme Peron, Ohara Rayel, Thiago Passarin **Feasibility Study of Wind Energy Potential in Turkey Case Study of Catalca District in Istanbul** Mohammed Wadi, Bedri Kekezoglu, Mustafa Baysal, Mehmet Rida Tur, Abdulfetah Shobole
19:00-21:00 **Hilton Doha Pool Area**	**Welcome Reception**

Day Two
20 November 2019

08:30-10:00 **Nashira 1**	*Renewable Energy and Energy Storage Systems 2* Chairs: Omar Ellabban, Yushan Liu **Design of an Intelligent Energy Management System for Standalone PV/Battery DC Microgrids** Abdulrahman Alassi, Omar Ellabban **Bi-stable Shape Memory Alloy Actuated Switch for Smart PV Skin** Moustafa Raslan, Robert S. Balog **Optimal Configuration for Building Integrated Photovoltaics System To Mitigate The Partial Shading on Complex Geometric Roofs** Saoud Al-Janahi, Omar Ellabban, Sami Al-Ghamdi **Performance Evaluation of Deep Recurrent Neural Networks Architectures: Application to PV Power Forecasting** Mohamed Massaoudi, Ines Chihi, Lilia Sidhom, Mohamed Trabelsi, Shady S. Refaat, Fakhreddine S. Oueslati **A Novel Methodology to Determine the Maximum PV Penetration in Distribution Networks** Mohammad Zain ul Abideen, Omar Ellabban, Shady S. Refaat, Haitham Abu-Rub, Luluwah Al-Fagih
08:30-10:00 **Qamar 1**	*Power Electronics and Applications 2* Chairs: Sevki Demirbas, Samet Biricik **Non-Overshooting Controller for High-Power Multi-Port DC-DC Converters** Mohammad Khodadady, Nader Meskin, Ahmed Massoud

08:30-10:00 Qamar 1	**Sensorless Low Speed Pmsm Motor Control With Cogging Torque Compensation** Jaroslaw Guzinski, Krzysztof Luksza, Marcin Morawiec, Patryk Strankowski, Zbigniew Krzeminski, Abdellah Kouzou **Analysis of Low Frequency Grid Current Harmonics Caused by Load Power Pulsation in a 3-Phase PFC Rectifier** Julian Böhler, Florian Krismer, Johann W. Kolar **Multimodule DC-DC Converters for High-Voltage High-Power Renewable Energy Sources** Mena ElMenshawy, Ahmed Massoud **Design of a digital PWM module with independent carrier amplitude modulation control** Saikat Jana, Srirama Srinivas
08:30-10:00 Qamar 2	*Power Generation, Transmission and Distribution 2* Chairs: Adel Gastli, Shady Khalil **Implementation and Performance Assessment of Fast Active Power Injection Method for Type 4 Wind Turbine based on Real-time Simulation** Elyas Rakhshani, Nidarshan Veerakumar, Zameer Ahmad, Jose Rueda Torres, Mart A.M.M. van der Meijden, Peter Palensky **Optimal Linear Quadratic Regulator Design of Interconnected Systems with VSP based HVDC Links for Inertia Emulation** Elyas Rakhshani, Iman M. H. Naveh, Hasan Mehrjerdi, Jose Rueda Torres, Peter Palensky **Protection of Transmission Line in Presence of Parallel Capacitance Elements** Abdelrahman Abdalla, Ahmed Aljabery, Hasan Mehrjerdi **Impact of SCFCL on Fault Current Level in Active Distribution Networks: Matlab/Simulink Case Studies** Sawsan Sayed, Mena Elmenshawy, Mariam Elmenshawy, Ahmed Massoud **S-Transform Based Protection Scheme for Distribution System integrated with Solar Power Plant** Mahmood Shaik, Abdul Gafoor Shaik, Sandeep Kumar Yadav

10:00-10:30 **Nashira Foyer**	Coffee Break
10:30-11:30 **Nashira 1**	*Keynote 3:* **Microgrids Research and Applications: Smart Homes, EV Charging Stations, Electrical Ships and Seaports** Prof. Josep M. Guerrero, Aalborg University, Denmark Moderator: Dr. Veronica Bermudez Benito, Qatar Environment and Energy Research Institute, Doha, Qatar
11:30-12:30 **Nashira 1**	*Smart Grid Technologies and Applications 2* **Chairs:** Ali H. Alaboudy, Shady Khalil **Frequency and Voltage Restoration for Droop Controlled AC Microgrids** Anas Karaki, Miroslav Begovic, Sertac Bayhan, Haitham Aburub **Real-Time Electricity Sub-metering and Monitoring System for Qatar Greener Schools Initiative** Omar Ellabban, Abdulrahman Alassi, Mariam Fliss, Saleh AL-Marri **Design of Multivariable PI Controller Using Evolutionary Algorithms for VSP based AC/DC Interconnected Systems** Iman Mohammad Hosseini Naveh, Elyas Rakhshani, Hasan Mehrjerdi, Jose Rueda Torres, Peter Palensky **MVMO-based tuning of Active Power Gradient Control of VSC-HVDC links for Frequency Support** Jose Rueda Torres, Arcadio Perilla, Elyas Rakhshani, Peter Palensky, Mart A.M.M. van der Meijden, Alex Alefragkis
11:30-12:30 **Qamar 1**	*Power Electronics and Applications 3* Chairs: Samet Biricik, Burcin Ozmen **A Railway Power Conditioner Using Direct AC-AC Modular Multilevel Converter** Futian Qin, Tianqu Hao, Feng Gao, Decun Niu **Harmonic Current Detection Based on The Dual-Tree Complex Wavelet Transform** Burcin Ozmen, Samet Biricik

11:30-12:30 Qamar 1	**Super Twisting Algorithm Based Sliding Mode Control Method for Single-Phase Dynamic Voltage Restorers** Hasan Komurcugil, Samet Biricik, Ebrahim Babaei **A Novel Switched-Capacitor Five-Level T-Type Inverter** Decun Niu, Tianqu Hao, Feng Gao, Futian Qin, Zhan Ma, Kangjia Zhou, Wei Li
12:30-13:30 **Nashira 2**	Lunch
14:00-14:45 **Nashira 1**	**Student and Young Professionals Industry Link** *Innovations to Realize Smart Cities: From Idea to Market* Dr. Adnan Abu-Dayya**,** CEO, Qatar Mobility Innovations Center, Doha, Qatar Moderator: Dr. Munir Tag, Qatar National Research Fund, Doha, Qatar
14:45-15:00 **Nashira Foyer**	Coffee Break
15:00-15:45 **Nashira 1**	**Student and Young Professionals Industry Link** *Energy Storage for Smart Grid Applications* Prof. Said Al-Hallaj, University of Illinois at Chicago, USA CEO and Co-funder of All Cell Technologies LLC, Chicago, USA Moderator: Prof. Atif Iqbal, Qatar University, Doha, Qatar
19:00-21:00 **Nashira 2**	**Gala Dinner and Award Ceremony**

Day Three
21 November 2019

08:30-10:00 **Nashira 1**	***Power Electronics and Applications 4*** Chairs: Yushan Liu, Omar Ellabban **Control of a Hybrid IGBT-SiC Inverter** Jens Onno Krah, Joachim Holtz, Benjamin Sahan **Photovoltaic Supplied Three-Phase T-Type Inverter with Harmonic Current Compensation Capability** Zahera Batool, Hasan Komurcugil, Samet Biricik, Tuan Ngo, Tuyen Vu **Single Stage High Gain Transformerless Three Phase PV Inverter** Balaji Veerasamy, Sundaram Maruthachalam, Kanagaraj Jagannathan, Takaharu Takeshita **Model Predictive Control of a 9-Level Packed U-Cells based Grid-Connected PV System** Abdelbasset Krama, Shady S. Refaat, Mohamed Trabelsi **Smooth Grid Synchronization in Weak AC Grid with High Wind Energy Penetration using Distribution Static Compensator** Gajendra singh Chawda, Abdul Gafoor Shaik **Average Model based Effective Control Approach for a Grid-Connected PV PUC5 Inverter** Khaled Rayane, Mohamed Bougrine, Atallah Benalia, Mohamed Trabelsi, Shady S. Refaat

08:30-10:00 Qamar 1	*Smart Grid Technologies and Applications 3* **Chairs:** Ahmed Massoud, Mohamed Trabelsi
	The Impact of Water Trees and Cavities on the Electric Field Distribution in XLPE Power Cables Mohammad AlShaikh Saleh, Shady S. Refaat
	A Matlab/Simulink-Based Average-Value Model of Multi-Terminal HVDC Network Sawsan Sayed, Ahmed Massoud
	NB-PLC Successful Transmission Probability Analysis Mariam Fliss, Javier Fernandez, Aymen Omri, Gabriele Oligeri
	Partial Discharge Inception Voltage Measurement for an Artificially Created Void Inside the Solid Dielectric Mahboob Hassan, Nabila Elbeheiry, Shady S. Refaat
	Partial Discharge Localization in Gas-Insulated Switchgear using Various Learning Algorithms Omar Abu-Rub, Ahmad Darwish
	Hardware in the Loop Simulation of a Nano-Grid Transactive Energy Exchange Mladen Kezunovic, Milad Soleimani, Haitham Abu-Rub, Sertac Bayhan, Mohamed Trabelsi
08:30-10:00 Qamar 2	*Power Generation, Transmission and Distribution 3* Chairs: Shady Khalil, Atif Iqbal
	Feasibility study of a hybrid PV/Electrolyzer/FC and PV/Reformer/FC systems for supplying electricity to a residential in Chlef Mohamed Dekkiche, Toufik Tahri
	Analysis and forecasting of weather parameters in Chlef, Algeria, for solar energy applications Toufik Tahri
	Dielectric Behavior of Defects in Power Transformer Insulation using Finite Element Method Md Rashid Hussain, Shady S. Refaat

08:30-10:00 **Qamar 2**	**A Method of EV Detour-to-Recharge Behavior Modeling and Charging Station Deployment** Jiahong Cai, Yuxuan Gao, Xinyan He, Huimiao Chen **An Assessment of Different Electricity Tariffs on Residential Photovoltaic System Profitability: Australian Case Study** Rafah Al Arrouqi, Omar Ellabban, Muhammad Babar Rasheed, Luluwah Al-Fagih
10:00-10:30 **Nashira Foyer**	Coffee Break
10:30-12:15 **Nashira 1**	**Student and Young Professionals Tutorials** ***Rethinking the Global Energy Industry: towards Power Energy Century*** Dr. Veronica Bermudez Benito**,** Qatar Environment and Energy Research Institute, Doha, Qatar ***Using Sigma Delta Modulation for Current Measurement*** Jens Onno Krah**,** Professor, TH Koln, Germany Moderator: Prof. Haitham Abu-Rub, Texas A&M University at Qatar, Doha, Qatar
12:15-12:30 **Nashira 1**	**Closing Remarks**
12:00-13:30 **Nashira 2**	Lunch
14:00-16:30	Texas A&M University at Qatar Tour KAHRAMAA Awareness Park Tour

Keynote 1

Solid-State Transformer Applications – A Glimpse Into the Future

Johann W. Kolar
Professor
ETH Zurich, Switzerland

Smart and/or Solid-State Transformers (SSTs) are power electronics interfaces between medium voltage and low-voltage AC or DC grids and are employing medium-frequency transformers for providing galvanic isolation and voltage scaling. Accordingly, SSTs show a high power density and are offering excellent controllability of the active and reactive power flow and/or voltage and current level and shape, as well as active protection features.

This talk will first will first review current Megatrends, such as Clean Energy, Digitalization, Urbanization/Smart Cities, Sustainable Mobility, etc., and identify corresponding future applications for SST systems, especially in the context of DC microgrids and DC power distribution applications in datacenters, larger EV charging facilities, DC collector grids of off-shore wind parks, and future hybrid propulsion aircraft. Next, the talk covers key power converter topologies for the realization of SST systems which includes basic isolated DC/DC converter topologies, multi-cell converter structures with input-series / output-parallel (ISOP) configuration to achieve modularity and high reliability through redundancy, and structural options for realizing three-phase connectivity, as well as hybrid transformers. First industrial SST prototype systems are discussed to illustrate the practical applicability of the concepts. Finally, examples of current research activities on SST systems at ETH Zurich will be presented, including a highly compact/efficient 10kV-SiC-MOSFET-based converter module for future datacenter or ultra-fast EV charging applications.

Johann W. Kolar received his M.Sc. degree in industrial electronics and control engineering (with highest honors) and the Ph.D. in electrical engineering (summa cum laude / promotio sub auspiciis praesidentis rei publicae) from the Vienna University of Technology, Austria, in 1997 and 1999, respectively. Since 1984 he has been working as an independent researcher and international consultant in close collaboration with the Vienna University of Technology, in the fields of power electronics, industrial electronics and high performance drives. He was appointed Associate Professor and Head of the Power Electronic Systems Laboratory at the Swiss Federal Institute of Technology (ETH) Zurich on 1 February, 2001, and was promoted to the rank of Professor. in 2004. Dr. Kolar has proposed numerous novel converter topologies and modulation and control concepts, e.g., the VIENNA Rectifier, the SWISS Rectifier, the Delta-Switch Rectifier, the 1/3 Rectifier, the Isolated Y-Matrix AC-DC Converter, and the three-phase AC-AC Sparse Matrix Converter. He has published more than 600 scientific papers at main international conferences, more than 280 papers in international journals, and four book chapters. Furthermore, he has filed 1more than 90 patents. He has presented more than 20 educational seminars at leading international conferences and has served as IEEE PELS Distinguished Lecturer from 2012 through 2016.

Dr. Kolar is a Fellow of the IEEE, a member of the IEEJ, and a member of International Steering Committees and Technical Program Committees of numerous international conferences in the field (e.g. Director of the Power Quality Branch of the International Conference on Power Conversion and Intelligent Motion). He is the founder and chair of the IEEE PELS Austria Chapter (1997-2001) and of the IEEE PELS Switzerland Chapter (2001-2011), and Chairman of the Education Chapter of the European Power Electronics (EPE) Association (since 2001). From 1997 through 2000 he has been serving as Associate Editor of the *IEEE Transactions on Industrial Electronics* and from 2001 through 2013 as Associate Editor of the *IEEE Transactions on Power Electronics*. Since 2002 he also is an Associate Editor of the *Journal of Power Electronics* of the Korean Institute of Power Electronics and a member of the Editorial Advisory Board of the IEEJ *Transactions on Electrical and Electronic Engineering*.

Keynote 2

Model-based Design and Operations of Smart Energy Systems

Peter Palensky,
Professor
TU Delft, Netherlands

The smart grid is the ICT answer to the power challenges of tomorrow: flexible loads, active distribution grids, storage management, smart energy markets, and bidirectional power flows. Conceptually it is a distributed ICT and automation system that is amalgamated with the physical power infrastructure: a cyber-physical system, and even a system of systems. Designing, optimizing, running, and diagnosing such systems requires reliable and scalable computational models which leads us to the main problem with cyber-physical systems: hybrid models (discrete and continuous) are hard to deal with. There are, however, new and promising languages and methods to deal with such systems.

This talk will introduce you to the challenges of describing such complex energy systems and show you how modern modeling methods can overcome the hurdles. Ultimately, such models are capable of covering technical constraints, economic drivers, and complex interactions in several magnitudes of time.

Peter Palensky is Professor for intelligent electric power grids at TU Delft, and Principal Investigator at the Amsterdam Metropolitan Solutions (AMS) Institute, both Netherlands. He also serves as Director of TU Delft's PowerWeb Institute.

Before that he was Principal Scientist for Complex Energy Systems at the Austrian Institute of Technology (AIT) / Energy Department, Austria, Head of Business Unit "Sustainable Building Technologies" at the AIT, CTO of Envidatec Corp., Hamburg, Germany, Associate Professor at the University of Pretoria, South Africa, Department of Electrical, Electronic and Computer Engineering, University Assistant at the Vienna University of Technology, Austria, and researcher at the Lawrence Berkeley National Laboratory, California.

He is active in international committees such as IEEE and is Editor in Chief of the *IEEE Magazine on Industrial Electronics*. His main research field is complex energy systems.

Keynote 3

Microgrids Research and Applications: Smart Homes, EV Charging Stations, Electrical Ships and Seaports

Josep M. Guerrero
Professor
Aalborg University, Denmark

A microgrid is an electrical distribution network consisted of distributed generators, local loads, and energy storage systems that can operate in grid-connected or islanded modes. Different technologies are combined together, such us power converters, control, communications, optimization, and so on. This way the energy can be generated and stored near to the consumption points, improving the stability and reducing the losses produced by the large power lines. In distributed energy systems like microgrids, multi-agent systems technologies will be presented distributed control is a powerful tool for distributed.

In this talk examples of research and projects in real sites including conventional islanded systems installed in islands and rural remote areas, low-voltage distribution systems and AC and DC microgrids for residential applications and homes electrical vehicle charging stations, ships, vessels, and ferries, and seaports will be shown.

Josep M. Guerrero received the B.S. in telecommunications engineering, the M.S. in electronics engineering, and the Ph.D. in power electronics from the Technical University of Catalonia, Barcelona, in 1997, 2000 and 2003, respectively. Since 2011, he has been a Professor with the Department of Energy Technology, Aalborg University, Denmark, where he is responsible for the Microgrid Research Program (www.microgrids.et.aau.dk). From 2014 he was chair Professor in Shandong University; from 2015 he was a distinguished guest Professor in Hunan University; and from 2016 he was a visiting professor fellow at Aston University, UK, and a Guest Professor at the Nanjing University of Posts and Telecommunications.

His research interests is oriented to different microgrid aspects, including power electronics, distributed energy-storage systems, hierarchical and cooperative control, energy management systems, smart metering and the internet of things for AC/DC microgrid clusters and islanded minigrids; recently specially focused on maritime microgrids for electrical ships, vessels, ferries and seaports. Prof. Guerrero is an Associate Editor for a number of IEEE Transactions. He has published more than 450 journal papers in the fields of microgrids and renewable energy systems, which are cited more than 30,000 times. He received the best paper award of the *IEEE Transactions on Energy Conversion* for the period 2014-2015, and the best paper prize of IEEE-PES in 2015. As well, he received the best paper award of the *Journal of Power Electronics* in 2016. During five consecutive years, from 2014 to 2018, he was awarded by Thomson Reuters as Highly Cited Researcher. In 2015 he was elevated to IEEE Fellow for his contributions on "distributed power systems and microgrids."

Student & Young Professionals Activities - Industry Link

Energy Storage for Smart Grid Applications

Said Al-Hallaj
Research Professor
University of Illinois at Chicago, USA
CEO and Co-funder of All Cell Technologies LLC, USA

Lower renewable energy cost and escalating environmental concerns in the past 5-10 years have accelerated global deployment of renewable energy systems. However, further deployment of solar and wind energy systems is currently hindered due to the intermittent nature of these types of renewable energies. This intermittency problem combined with climate change impacts is causing grid instability and the mismatch between energy generation and demand which is leading to serious power infrastructure problems and significantly higher energy cost, especially during peak demand period. Many researchers, utilities, and regulators are evaluating various alternatives to mitigate these issues and energy storage is emerging as a leading candidate to address these challenges and facilitate further deployment of renewable energy technologies.

An overview of electrical and thermal energy storage technologies will be presented in this work but will focus on small to mid-size energy storage technologies for demand charge avoidance in commercial and industrial applications. The appropriate selection of a particular technology depends on the system requirements for the type of energy to be stored/used, discharge rate, capacity, lifetime, and cost. Lithium-ion batteries are a prominent candidate for smart grid applications due to their high specific energy and power, long cycle life, and recent reductions in cost. Special attention in this work will be on small to medium size grid-tied energy storage (i.e. 10 kW-500 kW) Li-ion battery and thermal energy storage systems that can help with demand charge reduction especially with applications that have a higher power to energy ratios.

Said Al-Hallaj is the CEO and co-founder of All Cell Technologies LLC and a Research Professor of chemical engineering at the University of Illinois at Chicago (UIC). Dr. Al-Hallaj earned his B.Sc and M.Sc in chemical engineering from Jordan University of Science and Technology (JUST) and a Ph.D in chemical engineering from the Illinois Institute of Technology (IIT). Al-Hallaj was co-authored a book entitled "*Hybrid Hydrogen Systems*" and has published several book chapters and the numerous number of peer-reviewed and conference journal papers. He is the co-inventor of several issued and pending patent applications in the areas of renewable energy, energy storage, and water desalination.

Student & Young Professionals Activities - Industry Link

Innovations to Realize Smart Cities: From Idea to Market

Adnan Abu-Dayya
Executive Director (CEO)
Qatar Mobility Innovations Center, Doha, Qatar

Given their emerging role in improving the quality of life for residents, enhancing operations efficiency and in driving economic development, realizing Smart Cities is becoming a hot topic all over the world which is driving innovations development and implementation.

In this talk, we will review QMIC's integrated innovations strategy for enabling Smart Cities. We will present real examples of Smart City initiatives that have been taken from the early R&D stage to the full market implementation stage especially in the areas of Intelligent Mobility and Environment & Sustainability.

Adnan Abu-Dayya led the establishment of the Qatar Mobility Innovations Center (QMIC) in 2009 at the Qatar Science & Technology Park. It is the first independent innovations institution in the region focused on translating R&D and technology innovations into scalable digital businesses in the field of Intelligent Mobility and Smart Cities platforms and solutions.

Before moving to Qatar in 2007, Adnan worked for 10 years at AT&T Wireless in Seattle, USA where he served in a number of senior management positions covering product innovations, emerging technologies, systems engineering, product realization, and intellectual property management. Before that, Adnan worked as a Senior Manager at Nortel Networks in Canada in the advanced technology group, and as a Senior Consultant at the Communications Research Centre in Ottawa, Canada.

Dr. Adnan serves as the Chairman of the Advisory Board of the Electrical & Computer Engineering Program Texas A&M University at Qatar and is a member of the Steering Committee of the Smart Grid Research Center at Texas A&M University at Qatar.

Adnan received his Ph.D. in digital mobile communications (electrical engineering) from Queens University, Canada, in 1992. He has 10 issued patents and about 100 referre publications.

Student & Young Professionals Activities - Tutorial

Rethinking the Global Energy Industry: Towards Power Energy century

Verónica Bermúdez Benito, Ph.D.
Senior Research Director
Qatar Environment Research Institute, Doha, Qatar

The Paris agreement sent a signal around the world; climate is a serious threat. To tackle this challenge the energy system requires a complete re-wiring of the global economy in just 50 years. We will only be able to do so if we engage all the different players: science, technology development, policy makers, … Energy enable the whole economy to function and will enable billion of people to pursuit a better life through clean water, sanitation, nutrition, health care, education,…, and all of that thanks to green energy access.

Sustainable energy technologies available today are taking an increasing role in the energy industry, reshaping it, which presents a thread to legacy oil and gas operations. In fact, oil majors are progressively rethinking their strategies, transitioning and transforming into energy companies to accompany the world electrification and the sustainable development goals in a healthy and sustainable economy and business model.

Dr. Verónica Bermúdez Benito is Senior Research Director at QEERI (Qatar Environment Research Institute) where she is the Director of the Energy Center and leads the efforts in research, technology development and innovation in Energy. Prior to joining the organization in 2018, she was Acting General Manager of the Technology Division of the Atsugi Research Center at Solar Frontier KK in Japan. She has also hold a position of Principal Scientist at EDF R&D, Senior Scientist at NEXCIS (start-up, where she took part of the founding team) and Head of the Optoelectronic Characterization Laboratory at IRDEP (EDF) in France, between others. And it is in the Advisory Board of a number of entities.

Verónica has a PhD in Physics from the Universidad Autónoma de Madrid (Spain), and holds a number of international awards for her research activity. She is an Associate Editor in Journal of Renewable and Sustainable Energy and acts as independent expert for a number of international funding agencies as the European Commission, and European National funding bodies.

She is also the author or co-author of more than 120 scientific papers in renown journals, including Nature, Nature Energy and Science, has deliver a large number of invited and keynote talks in several international conferences, as well as has a relevant patent portfolio. She has extensive experience in laboratory to industry research and technology transfer in the field of Renewable Energy, in almost the whole value chain, from materials development to grid integration for generation, storage and energy management solutions.

She is IEEE Senior Fellow and is actively engaged in promoting science among the youth, with a focus on STEM for women.

Her research interests sustainable energy solutions including PV alternative applications, and its integration in residential and added value markets, supported by battery deployment and energy management systems in smart grids opening the door to future clean transportation.

Student & Young Professionals Activities - Tutorial

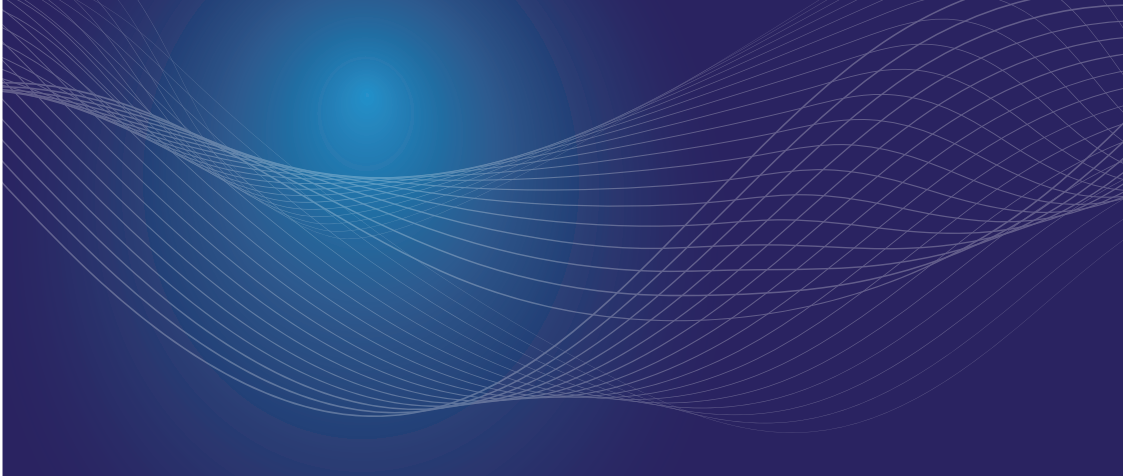**Using Sigma Delta Modulation for Current Measurement**

Jens Onno Krah
Professor
TH Koln, Germany

Sigma Delta based current measurement is used by a growing number of inverter manufacturers. Sigma Delta based Analog to Digital converters are characterized by the circumstance that the analog circuit part is very small. The majority of the circuit is digital, which offers great advantages in terms of implementation and signal processing. Meanwhile fully digital current sensors with Sigma Delta interface are offered. After an introduction to the Sigma Delta theory, the characteristics of this technique are presented:

- Sigma Delta Digital to Analog Converter
- Sigma-Delta Analog to Digital Converter
- Sinc Decimation Filter
- Current Measurement

Jens Onno Krah studied electrical engineering at the Bergische Universität Wuppertal and received his doctorate in 1993 from Prof. Joachim Holtz in the field of electric machine and drive research. Until February 2004 he was Technical Director responsible for the development of Kollmorgen Servo Drives.

Since 2004 Prof. Krah has been teaching control engineering, motion control, FPGA-based digital signal processing and functional safety at the TH Köln. The research focus is on the development of robust, safety-related and energy-efficient inverter control with programmable hardware.