Conference Abstract

2018 the 6th IEEE International Conference on Smart Energy Grid Engineering

(IEEE SEGE 2018)

August 12-15, 2018

UOIT, Oshawa, Canada

Sponsored by:

IEEE Toronto Section est. 1903 — Advancing Technology for Humanity

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Dr. Hossam A. Gabbar, UOIT, Canada

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Prof. Miguel F. Anjos, Polytechnique Montréal, Canada

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Ruth Milman, UOIT, Canada

Treasurer

Manir U. Isham, Loyalist College, Canada

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Welcome Message from Conference Chair

Dr. Hossam A. Gabbar (UOIT),

Founder and General Chair of IEEE SEGE

It is our great pleasure to invite you to join our international conference on Smart Energy Grid Engineering (SEGE), which is sponsored by IEEE. This event will provide unique opportunity to have fruitful discussions about smart energy grid infrastructures, technologies, engineering design methods, and best practices that address industrial challenges. The event includes large number of speakers and quality papers that cover energy generation, transmission and distribution infrastructures, energy storage, electrification, information and communications, and security. We look forward to welcoming you at UOIT, Ontario, Canada.

The SEGE conference aims at providing an opportunity to discuss various engineering challenges of smart energy grid design and operation by focusing on advanced methods and practices for designing different components and their integration within the grid. It also provides a forum for researchers from academia and professionals from industry, as well as government regulators to tackle these challenges, and discuss and exchange knowledge and best practices about design and implementation of Smart Energy Grids.

I truly hope you'll enjoy the conference and get what you expect from the conference.

Instructions for Oral & Poster Presentations

Oral Presentations

- **Time:** a maximum of 20 minutes in total, including speaking time and discussion. Please make sure your presentation is well timed. Please keep in mind that the program is full and that the speaker after you would like their allocated time available to them.
- You can use CD or USB flash drive (memory stick), make sure you scanned viruses in your own computer. Each speaker is required to meet her / his session chair in the corresponding session rooms 10 minutes before the session starts and copy the slide file (PPT or PDF) to the computer.
- It is suggested that you email a copy of your presentation to your personal in box as a backup. If for some reason the files can't be accessed from your flash drive, you will be able to download them to the computer from your email.
- Please note that each session room will be equipped with a LCD projector, screen, point device, microphone, and a laptop with general presentation software such as Microsoft Power Point and Adobe Reader. Please make sure that your files are compatible and readable with our operation system by using commonly used fronts and symbols. If you plan to use your own computer, please try the connection and make sure it works before your presentation.
- Movies: If your Power Point files contain movies please make sure that they are well formatted and connected to the main files.

Poster Presentations

- Maximum poster size is 36 inches wide by 48 inches high (3ft.x4ft.)
- Posters are required to be condensed and attractive. The characters should be large enough so that they are visible from 1 meter apart.
- Please note that during your poster session, the author should stay by your poster paper to explain and discuss your paper with visiting delegates.

Dress code

- Please wear formal clothes or national characteristics of clothing.

Program at a Glance

August 12 Sunday (14:00-18:00)		
14:00-18:00	Room UA1240: Registration	
15:00-17:00	Room UA1120: Tutorial 1	
15:00-17:00	Room UA1220: Tutorial 2	
17:00-17:30	Room UA1140: Invited Speaker: Stephen Brown, CSA Group	
17:30-18:00	Room UA Atrium: Welcome Reception	
August 13 Monday (8:30-18:20)		
8:30-16:00	Room UA1240: Registration	
8:30-8:45	Room UA1350: SEGE Opening, Welcome Message	
8:45-9:30	Room UA1350: Keynote Speech - Dr. Elna Holmberg	
9:30-10:15	Room UA1350: Keynote Speech - Dr. Hossam A. Gabbar	
10:15-10:45	Room UA Atrium: Coffee break / Exhibition	
10:45-11:30	Room UA1350: Keynote Speech - Dr. Hussein Mouftah	
11:30-12:15	Room UA1350: Keynote Speech - Dr. Bala Venkatesh	
12:15-13:15	Lunch	
13:15-15:35	Room UA1220: Session-1	Room UA1120: Session-2
15:35-16:00	Room UA Atrium: Coffee break / Exhibition	
16:00-18:20	Room UA1220: Session-3	Room UA1120: Session-4
August 14 Tuesday (8:30-20:00)		
8:30-16:00	Room UA1240: Registration	
8:30-9:15	Room UA1350: Keynote Speech - Dr. Loi Lei Lai	
9:15-10:00	Room UA1350: Keynote Speech - Dr. Miguel F. Anjos	
10:00-10:30	Room UA Atrium: Coffee break / Exhibition	
10:30-11:15	Room UA1350: Keynote Speech - Dr. Bingyin Xu	
11:15-12:15	Room UA1350: Panel Discussion-1	
12:15-13:15	Lunch	
13:15-14:55	Room UA1220: Session-5	Room UA1120: Session-6
14:55-15:55	Room UA1350: Panel Discussion -2 - Dr. Katherine Sparkes	
15:55-16:25	Room UA Atrium: Coffee break / Exhibition	
16:25-18:45	Room UA1220: Session-7	Room UA1120: Session-8

18:45-20:00	Dinner	
August 15 Wednesday (8:30-17:20)		
8:30-16:00	Room UA1240: Registration	
8:30-9:15	Room UA1350: Keynote Speech - Prof. Gerry Moschopoulos	
9:15-10:00	Room UA1350: Invited Speech - Dr. Huimin Li	
10:00-10:45	Room UA1350: Invited Speech - Dr. Mohamed Safiuddin	
10:45-11:15	Room UA Atrium: Coffee break / Exhibition	
11:15-11:45	Room UA1350: Invited Speech - Mr. Dan Ruby	
11:45-13:00	Lunch	
13:00-15:20	Room UA1220: Session-9	Room UA1120: Session-10
15:20-16:20	UOIT/ACE Tour	
16:20-17:20	Room UA1220: Closing Ceremony	

Keynote Speakers

Dr. Hossam A. Gabbar
University of Ontario Institute of Technology (UOIT), Canada

Dr. Gabbar is a full Professor in the University of Ontario Institute of Technology (UOIT) in the Faculty of Energy Systems and Nuclear Science, and cross appointed in the Faculty of Engineering and Applied Science, where he has established both the Energy Safety and Control Lab (ESCL) and Advanced Plasma Engineering Lab. He is the recipient of the Senior Research Excellence Aware for 2016, UOIT. He is leading national and international research in the areas of smart energy grids, safety and control systems, advanced plasma systems and their applications on nuclear, clean energy and production systems. He is leading research in Canada with international recognition in energy safety and control for nuclear and energy production facilities. Dr. Gabbar obtained his B.Sc. degree in 1988 with first class of honor from the Faculty of Engineering, Alexandria University (Egypt). In 2001, he obtained his Ph.D. degree from Okayama University (Japan) in the area of Safety Engineering. From 2001 till 2004, he joined Tokyo Institute of Technology (Japan), as a research associate in the area of process systems engineering. From 2004 till 2008, he joined Okayama University (Japan) as a tenured Associate Professor, in the Division of Industrial Innovation Sciences. From 2007 till 2008, he was a Visiting Professor at the University of Toronto, in the Mechanical Engineering Department.

He has more than 220 publications, including patents, books / chapters, journal and conference papers. He been invited and participated in world-known conferences and delivered plenary talks on number of scientific events and invitations to international universities. He has supervised and hosted undergraduate, graduate, postdocs, visiting researchers and scholars from different countries including: Japan, India, Qatar, Egypt, Mexico, Malaysia, China, Brazil, Chile, UAE, and Colombia.

He participated and led several large scale national and international projects, in Japan, China, Middle East, and Canada, related to smart energy grids, intelligent control systems and safety design and operation synthesis and optimization of energy systems, micro energy grids, and integrated gas-power grids. He developed novel solutions for risk-based smart energy grid design, protection, and control and hybrid energy supply systems. He proposed new integrated energy storage system based on flywheel and battery, and applied on power substations, transportation electrification, and urban infrastructures. Dr. Hossam Gaber has scholarly research in the area of smart energy grids, and control optimization of micro grid and transportation electrification technologies, and his recent book on Smart Energy Grid Engineering was published with national and international recognition. Dr. Gaber is regularly consulted and provide technical support for advanced energy systems in China, Middle East, Japan, and Canada, and invited to give lectures in number of national and international events in the area of smart energy grids. He is leading a research team for a funded project by Chinese government to design and deploy hybrid energy storage systems. He is the founding general chair of the annual IEEE Smart Energy Grid

Engineering Conference, which is held in Canada.

Dr. Gabbar has been active in leading national and international scientific and community events and activities, including: Nuclear Safety Standards within CSA – Canadian Standard Association, IEEE Annual Conference on Smart Energy Grid Engineering (SEGE), IEEE Nuclear and Plasma Sciences Society (NPSS) Symposium on Real Time Measurement, Instrumentation, and Control (RTMIC), IEEE Nuclear and Plasma Sciences Society Symposium on Plasma and Nuclear Systems (SPANS), and other international events. He is the Editor-in-Chief of the International Journal of Process Systems Engineering (IJPSE), and member of IEEE Smart Grid Committees.

Elna Holmberg
Chalmers University of Technology, Sweden

Dr. Elna Holmberg is the director of a national centre of excellence for hybrid and electric vehicles and charging; the Swedish Electromobility Centre. The centre unites Swedish e mobility expertise and is a node for interaction between academia, industry and society.

Elna Holmberg received her PhD on numerical simulations on turbulent combustion. Dr. Holmberg has since worked mainly in the automotive industry in different managerial positions focusing a variety of areas, from engineering and styling to academic research, both for cars and heavy vehicles.

Later, as Research Leader withing R&D at AB Volvo, she focused on future vehicle systems and the need for developing both competences and solutions.

After several years in product development, Dr. Holmberg resumed her contacts with academy to take up the challenge to build a national centre for hybrid and electric vehicles, a position which still captures her attention.

Miguel F. Anjos
Polytechnique Montréal, Canada

Miguel F. Anjos is Full Professor in the Department of Mathematics and Industrial Engineering of Polytechnique Montreal, where he holds the NSERC-Hydro-Quebec-Schneider Electric Industrial

Research Chair on Optimization for the Smart Grid, and the Inria International Chair on Power Peak Minimization for the Smart Grid. He received the B.Sc. degree from McGill University, the M.S. from Stanford University, and the Ph.D. degree from the University of Waterloo, and is a Licensed Professional Engineer in Ontario, Canada. His research interests are in the theory, algorithms and applications of mathematical optimization. He is particularly interested in the application of optimization to problems in power systems management and smart grid design. He is the Founding Academic Director of the Trottier Institute for Energy at Polytechnique, which he led from its inauguration in May 2013 until August 2016. Under his leadership, the Institute published several White Papers on the Canadian energy landscape. He is a former Editor-in-Chief of Optimization and Engineering, and serves on several other editorial boards. He was elected to three-year terms on the Council of the Mathematical Optimization Society and as Program Director for the SIAM Activity Group on Optimization, and to a two-year term as Vice-Chair of the INFORMS Optimization Society. He has served on the Mitacs Research Council since its creation in 2011. His allocades include a Canada Research Chair, the Méritas Teaching Award, a Humboldt Research Fellowship, the title of EUROPT Fellow, and the Queen Elizabeth II Diamond Jubilee Medal. He is a fellow of the Canadian Academy of Engineering.

Hussein Mouftah
University of Ottawa, Canada

Hussein T. Mouftah received the BSc in Electrical Engineering and MSc in Computer Science from the University of Alexandria, Egypt, in 1969 and 1972, respectively, and the PhD in Electrical Engineering from Laval University, Canada, in 1975. He joined the School of Electrical Engineering and Computer Science (was School of Information Technology and Engineering) of the University of Ottawa in 2002 as a Tier 1 Canada Research Chair Professor, where he became a University Distinguished Professor in 2006. He has been with the ECE Dept. at Queen's University (1979-2002), where he was prior to his departure a Full Professor and the Department Associate Head. He has six years of industrial experience mainly at Bell Northern Research of Ottawa (Nortel Networks). He served as Editor-in-Chief of the IEEE Communications Magazine (1995-97) and IEEE ComSoc Director of Magazines (1998-99), Chair of the Awards Committee (2002-03), Director of Education (2006-07), and Member of the Board of Governors (1997-99 and 2006-07). He has been a Distinguished Speaker of the IEEE Communications Society (2000-2007). He is the author or coauthor of 12 books, 73 book chapters and more than 1500 technical papers, 14 patents, 6 invention disclosures and 147 industrial reports. He is the joint holder of 24 Best/Outstanding Paper Awards. He has received numerous prestigious awards, such as the 2017 C.C. Gotlieb Medal in Computer Engineering and Science and the 2016 R.A. Fessenden Medal in Telecommunications Engineering of IEEE Canada, the 2015 IEEE Ottawa Section Outstanding Educator Award, the 2014 Engineering Institute of Canada K. Y. Lo Medal, the 2014 Technical Achievement Award of the IEEE Communications Society Technical Committee on Wireless Ad Hoc and Sensor Networks, the 2007 Royal Society of Canada Thomas W. Eadie Medal, the 2007–2008 University of Ottawa Award for

Excellence in Research, the 2008 ORION Leadership Award of Merit, the 2006 IEEE Canada McNaughton Gold Medal, the 2006 EIC Julian Smith Medal, the 2004 IEEE ComSoc Edwin Howard Armstrong Achievement Award, the 2004 George S. Glinski Award for Excellence in Research of the University of Ottawa Faculty of Engineering, the 1989 Engineering Medal for Research and Development of the Association of Professional Engineers of Ontario, and the Ontario Distinguished Researcher Award of the Ontario Innovation Trust. Dr. Mouftah is a Fellow of the IEEE (1990), the Canadian Academy of Engineering (2003), the Engineering Institute of Canada (2005) and the Royal Society of Canada RSC Academy of Science (2008).

Gerry Moschopoulos
Western University, Canada

Gerry Moschopoulos received the B.Eng., M.A.Sc., and Ph.D. degrees from Concordia University, Montreal, QC, Canada, in 1989, 1992, and 1997, respectively, all in electrical engineering.

From 1996 to 1998, he was a Design Engineer in the Advanced Power Systems Division, Nortel Networks, Lachine, QC, Canada. From 1998 to 2000, he was a Postdoctoral Fellow at Concordia University, where he was involved in research in the area of power electronics for telecommunications applications. He is a Professor at the Western University, London, ON, Canada and a Registered Professional Engineer in the province of Ontario.

Dr. Moschopoulos is currently an Associate Editor for the IEEE Transactions on Power Electronics and the IEEE Journal of Emerging and Selected Topics in Power Electronics. He is currently a Guest Editor for the Special Issue on Resonant and Soft-Switching Converters with Wide Bandgap Devices to be published next year in the IEEE Journal of Emerging and Selected Topics in Power Electronics. He has published over 200 papers in journals and conferences. His research interests include AC-DC power converters, DC-DC power converters, switch-mode power supplies for industrial applications, power electronics for renewable energy systems, and inverters.

Prof. Bala Venkatesh
Ryerson University, Canada

Bala Venkatesh is a Professor and Academic Director, Centre for Urban Energy, Ryerson University, Canada. His interests are in power systems analysis and optimization, with applications to energy

storage, transactive energy systems and renewables. He heads the NSERC Energy Storage Technology (NEST) Network. He is a registered professional engineer in the province of Ontario.

Loi Lei Lai
Guangdong University of Technology, Guangzhou, China

Professor Loi Lei Lai received the BSc (first class Hons., the only one) degree in electrical and electronic engineering and the PhD degree in electrical and electronic engineering from the University of Aston, Birmingham, UK in 1980 and 1984 respectively, and the DSc degree in electrical, electronic, and information engineering from City, University of London, UK in 2005. Currently, he is University Distinguished Professor at the Guangdong University of Technology, Guangzhou, China. He was Director of the Research and Development Centre, Beijing, China, the Pao Yue Kong Chair Professor, Guest Professor, the Vice President and Professor and Chair in Electrical Engineering for the State Grid Energy Research Institute, Beijing, China; Zhejiang University, Hangzhou, China; Fudan University, Shanghai, China; IEEE Systems, Man, and Cybernetics Society (IEEE/SMCS), USA; and City, University of London, respectively. He conducted high-level consultancy for major international projects such as the Channel Tunnel between UK and France. His research interests are in smart grid, clean energy, and computational intelligence applications in power engineering. Dr Lai is a Fellow of IEEE, IET, Distinguished Expert in State Grid Corporation of China, National Distinguished Expert in China, Member of IEEE Smart Grid Steering Committee, Member of IEEE Smart City Steering Committee and IEEE Industrial Electronics Society Fellow Evaluation Committee evaluator. He was the recipient of an IEEE Third Millennium Medal, IEEE Power and Energy Society (IEEE/PES) Power Chapter Outstanding Engineer Award in 2000, IEEE/PES Energy Development and Power Generation Committee Prize Paper in 2006 and 2009, People of the 2012 Scientific Chinese Prize, IEEE/SMCS Outstanding Contribution Award in 2013 and 2014, and is listed in the honor list of the 2014 the Thousand Talents Plan, China.

Bingyin Xu
Shandong University of Technology (SDUT), Zibo, China

Professor Bingyin Xu received the BSc and MSc degrees in Power System Protection and

Automation from Shandong University in 1982 and 1987 respectively, and the PhD in Power System Automation from Xian Jiaotong University in 1991.

Currently, he is Professor at the Shandong University of Technology (SDUT), Zibo, China. He is Director of the Smart Grid Research Centre, SDUT, Zibo, China, the Chairman of the board of Shandong Kehui Automation Co. Ltd, Member of Advisory Group to Smart Grids Projects of High Tech Development (863) Program of China, Member of Technical Committee of CIRED of China, Member of Advisory group to the Operation, Control and Protection Session of CIRED. His research interests are in smart grid, electrical power distribution, electrical power automation and protection and traveling wave fault location. Dr Xu is Taishan Scholars of Shandong Province, Recognized National Young and Middle-aged Expert with Outstanding Contribution by State Council of China. Dr. Xu won Returned Overseas Students Achievement Award by six ministries and committee of China. Dr. Xu also won second prize in National Technology Invention Award from The State Council of the People's Republic of China in 2007, second prize in Science and Technology Progress Award from Ministry of Education of the People's Republic of China in 2012 and fourth prize in National Technology Invention Award from the State Council of the People's Republic of China in 1993.

Invited Speakers

Mohamed Safiuddin
University at Buffalo, USA

Dr. Mohammed Safiuddin received B.E. (Electrical) degree from Osmania University, Hyderabad, India in 1959 and MSEE degree from the University of Illinois in 1960. Later he received MBA and Ph.D. degrees from the University at Buffalo [SUNY], in 1971 and 1982 respectively.

Having worked as Junior Engineer in Andhra Pradesh State Electricity Board (India) for over a year before arriving in the USA, he joined the Systems Control Department of Westinghouse Electric Corporation, Buffalo, New York in June of 1960 as an Associate Engineer. He progressed through the ranks of Engineer, Senior Engineer and Fellow Engineer positions to become Manager, Product/Strategic Planning in 1982 in the Power Electronics and Drive Systems Division and was later appointed Technical Advisor in the Marketing Department of the same Division. His interests in continuing education has kept him in close contact with the University at Buffalo (SUNY), where he did part-time teaching in early sixties and then served as Adjunct Associate Professor (‘77-‘91), and

Research Professor [’91-‘10]. He is currently Research Professor Emeritus [Advanced Technology Applications] in the Electrical Engineering Department of University at Buffalo [UB]. He is also President of STS International, a technology service firm he established in September 1985. His areas of technical interests cover static power conversion and optimal control systems as applied to industrial processes, renewable energy, and Smart Grid power systems. He has been awarded 10 patents in this field and has dozens of technical papers and conference presentations to his credit.

He is a Life Fellow ('93) of the IEEE and has served as Chairman of Industrial Controls Committee of IAS (1985-87), Chairman of Education Committee (1978-88), Director of the IEEE Buffalo Section (1983- 86), and Chairman of the Industrial Utilization Systems Department of IAS (1990-91). He was awarded the Roscoe Allen Gold Medal in 1957 by Osmania University, and was nominated for the prestigious B.G. Lamme scholarship of Westinghouse by his Division in 1968 and 1980. He was awarded "IUSD Award of Merit" in 1992 by the IEEE-Industry Applications Society for his contributions to industrial control technologies, and service to the IAS. He was recognized for meritorious achievement in continuing education by the IEEE-EAB award for the year 2000. He is a member of the Pi Mu Epsilon (Mathematics), Beta Gamma Sigma (Business) honor societies and an "Eminent Engineer" member of Tau Beta Pi (Engineering).

Huimin Li
Shandong University of Technology (SDUT), Zibo, China

Professor Huimin Li received the BSc and MSc degrees in Electrical Power Engineering from Xian Jiaotong University, Xian, China in 1984 and 1987 respectively, and the PhD in Electronic and Electrical Engineering from Strathclyde University, Glasgow, UK.

Currently, he is distinguished professor at the Shandong University of Technology (SDUT), Zibo, China, distinguished visiting professor at the Shandong University, Jinan, China and Chairman of board of GridNT Inc, Jinan, China. Dr Li worked as Member of Technical Staff for Nortel Networks in 1995-1998, Member of Scientific Staff in Bell Labs, Lucent Technologies in 1998-2000. Dr Li served as general managers for China subsidiaries of USA companies of BigBand Networks and Camiant Inc. in 2005-2008.

Dr Li‘s research interests are in smart grid, especially in smart grid protocols and communications. Dr Li applies state of art information and communication technologies in smart substation, metropolitan railway electrical automation and smart energy grid. Dr Li’s main contribution in smart

grid includes real-time big data processing, visualization of electrical power automation configuration, standard based modeling of electrical power systems and power system analysis using artificial intelligence. Dr Li is Distinguished Overseas Returnees Expert of Jinan City, Taishan Scholars of Shandong Province, and selected as an expert in the national Thousand Talents plan in 2016.

Katherine Sparkes
IESO

Katherine Sparkes is the Director of Innovation, Research and Development team within the IESO where she is responsible for driving initiatives in support of grid modernization and the removal of barriers to private sector investment in solutions that support the reliability, adequacy and affordability of Ontario's electricity supply. Her team works with partners across the energy sector and beyond to understand emerging technologies, services, practices and policies that will help meet Ontario's current and future electricity needs. Katherine previously held various leadership roles in Conservation and Demand Management leading the design of award-winning Conservation and Demand Management (CDM) programs. Katherine has worked in the consulting and non-profit sectors and taught at the Energy & Infrastructure Program at Osgoode Hall Law School. Katherine is an Urban Planner by training.

Dan Ruby
Ontario Centres of Excellence (OCE)

Dan Ruby joined OCE in 2016 as a Business Development Manager. He is currently responsible for Durham Region and surrounding areas. Dan's prior role was Economic Development Manager for the City of Vaughan, responsible for the Innovative Research, Development and Design convergence sector. In this capacity, Dan created and led the development of the Vaughan

International Commercialization Centre (VICC) initiative.

Dan has also founded four companies in his career along with a not for profit called ‘the Green Connections Network”. He holds an Honours Bachelor of Science from the University of Toronto.

Stephen Brown
CSA Group

Stephen has over 30 years of experience in the Technologies industry. Throughout that period, he has been responsible for standards development, product planning and management, regulatory affairs, international business development, and strategic planning.

Stephen joined CSA Group in 2002 and was responsible for over 2500 codes and standards within the Electrotechnical sector. In 2012, Stephen was appointed to a new role at CSA Group with a global mandate regarding Emerging Technologies and their “game changing” effects on safety, certification, standards, and international applicability for specific markets. This area includes Intelligent Buildings, Connected Homes and Interoperability, Nanotechnologies, Energy Storage, Alternative Energy and connected Vehicles, infrastructure, and cybersecurity. In 2016, Stephen was appointed as Director, Innovation.

Tutorial Speakers

Tutorial I:

Dr. Ahmed M. Othman, UOIT, Canada

Ahmed M. Othman is an ass. professor in the Electrical Power and Machine Department, Faculty of Engineering, Zagazig University, Zagazig, Egypt. He was awarded his Ph.D. in 2011 from Aalto (Helsinki University of Technology), Finland. Currently, he works as post-doctoral fellow at UOIT. His research activities are concerned with power systems operations, renewable energy, microgrid and the application of artificial intelligence and other heuristic optimization techniques to power systems.

Title: Computational Intelligence Techniques for Smart Energy and Transportation Infrastructures

Abstract: Computational Intelligence is essential for development and design of Interconnected Microgrids (IMGs) with effective strategies for integrated energy storage and hybrid Distributed Energy Resources (DERs). IMGs are linked with the distribution lines so that it can store energy in the off peak for re-use during the day. One potential application is the integration with the railway infrastructures as a new green technology. This goal can be achieved by proposing heuristic technique to enable interconnected MGs to work transparently with the recent energy storage. Railway transportation MG model is proposed to balance energy flows between trains moving and braking energy, energy storage system and a main power utility network. An energy optimization tool can be proposed for the interconnected railway-MG system. Artificial Bee Colony Algorithm (ABC) is proposed for achieving the economical cost during the operation. Digital simulation scenario can be validated by real data; the achieved results should confirm the impact and influence of the proposed strategies.

Tutorial II:

TBA

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Session 2: Information Systems and Communications

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SE0016	**Moises Henriques** and Jorge Cormane	Time Domain Voltage Unbalance Index Based on Second Order Voltage Tensor Theory
SE0099	Shamim Yousefi, **Farnaz Derakhshan**, and Ayub Bokani	Mobile Agents for Route Planning in Internet of Things using Markov Decision Process
SE0103	Ali Akbar Nasiri and **Farnaz Derakhshan**	An Agent Based Approach For Assignment Of Virtual Networks To Substrate Network For Software Defined Networking

Session 3: Smart Grid Design and Operations

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SE0079	**Emmanuel Kobina Payne**, Lu Shulin, Qian Wang, Licheng Wu	Design Concept of Thermal Behavior Condition Monitoring of Distributed Energy Resources Network System with ZigBee and GSM Technology in Remote and Rural Areas
SE0080	**Haroon Rasheed**, Farah Haroon and Nandana Rajatheva	Pulse Position modulation based Energy Detection for Smart Grid Communication
SE0087	Mohammad Hossein Yaghmaee and **Hossein Hejazi**	Design and Implementation of an Internet of Things Based Smart Energy Metering
SE0091	**Alaa Alaerjan**, Dae-Kyoo Kim, Hua Ming, and Khalid Malik	Using DDS Based on Unified Data Model to Improve Interoperability of Smart Grids
SE0035	**Prasertsak Charoen**, Marios Sioutis, Saher Javaid, Yuto Lim and Yasuo Tan	Fair Billing Mechanism for Energy Consumption Scheduling with User Deviation in the Smart Grid
SE0063	**Jun Wu**, Peng Zhang, Jianhua Li, Zeyang Liu	Ant Colony Cleaning Behavior Algorithm based Multicast for SDN in Smart Grid

Session 4: Transmission and Distribution, Smart Infrastructures

Paper ID	Authors	Title
SE0068	**Pegah Yazdkhasti,** Chris P. Diduch	A Mathematical Model for the Aggregated Power Consumptions of Air Conditioners

SE0074	**Chuantong Hao**, Haochen Hua, Yuchao Qin and Junwei Cao	A Class of Optimal and Robust Controller Design for Energy Routers in Energy Internet
SE3003	Fatemeh Ghalavand, **Ibrahim Al-Omari,** Hossine Kazemi Karegar, Hadis Karimipour	Hybrid Islanding Detection for AC/DC Network Using DC-link Voltage
SE0053-A	**Asm Ashraf Mahmud** and Paul Sant	A Real-Time daily Price Suggestions in the Smart Grid through stochastic approximation
SE0115	**Hasan Rafiq**, Hengxu Zhang, Huimin Li and Manesh Kumar Ochani	Regularized LSTM based Deep Learning Model: First Step Towards Real-Time Non-Intrusive Load Monitoring
SE3004	Majid Dehghani, **Wenyu Han**, Hadis Karimipour	Coordinated Fuzzy Controller for Dynamic Stability Improvement in Multi-Machine Power System
SE0019	**Amanjot Singh Toor** and A. K. Jain	A new Energy Aware Cluster Based Multi-hop Energy Efficient routing protocol for Wireless Sensor Networks

Session 5: Materials and Energy Engineering

Paper ID	Authors	Title
SE10001	**Dipender Kumar Dev**	Erosion Behaviour of Hydroturbine Material under Air Jet Erosion Tester Using D-Gun Coating
SE0013	**Jonathan Reynolds**, Muhammad Waseem Ahmad, Yacine Rezgui	District Heating Energy Generation Optimisation Considering Thermal Storage
SE0030	**Sui Cheng**, Sian-Jheng Lin	A Memory-Hard Blockchain Protocol
SE1006	**Enbang Wu**	The Effects of Clean Energy Development on China's Carbon Dioxide Emissions Control
SE0049	**Tarek Mahmoud Samy**	Nonlinear Capacitors power dissipation and its graphical visualisation

Session 6: Thermal Energy Systems

Paper ID	Authors	Title
SE0046	**Nasser Ayoub**, Farayi Musharavati, Shaligram Pokharel and Hossam Gabbar	An approach for energy conservation management systems in buildings
SE0005	**S. M. Shalaby**, A. E. Kabeel, A-Khalil, M. E. Zayed	Improvement of the thermal performance of the v-corrugated plate solar air heater with PCM by using insulated upper cover during night

SE3002-A	**Mo'tamad H. Bata**, Rupp Carriveau, David S.-K. Ting	Machine Learning in Demand Forecasting and Energy Management in Smart Water Grids
SE0105	**Balaji Venkatesh**	Thermal Energy Storage for Homes
SE0033	Arghya Mukherjee, Antara Ain, **Pallab Dasgupta**	Solar Irradiance Prediction from Historical Trends using Deep Neural Networks

Session 7: Energy Storage

Paper ID	Authors	Title
SE3005	**Ahmed M. Othman** , Hossam A. Gabbar	Design of Resilient Energy Storage Platform for Power Grid Substation
SE0027	Christoph Ruland, **Jochen Sassmannshausen**	Firewall for Attribute-based Access Control in Smart Grids
SE0047	**Nasser Ayoub**, Farayi Musharavati, Shaligram Pokharel and Hossam Gabbar	ANN model for energy demand and supply forecasting in a hybrid energy supply system
SE0069	**Christopher Rockx** and **Joseph Euzebe Tate**	Hybrid Planning Tool for Solar and Battery Systems in Ontario
SE0011-A	**Chitchai Srithapon**	The Smart System for On Field Meter Testing in PEA Thailand
SE0076	Humaid Al Badi, John Boland, David Bruce, **Mohammed Albadi**	Dust event impact on photovoltaic systems
SE0031-A	**David Hasurungan**	The Power System Analysis Study and Mitigation Output Fluctuations of 4 MWp On-Grid Solar PV Power Plant Integration in Badak LNG Bontang due to Cloud Passing

Session 8: Transportation Electrification

Paper ID	Authors	Title
SE0101	**Seyedmostafa Hashemi**, Nataly Bañol Arias, Peter Bach Andersen, Bjoern Christensen, Chresten Træholt	Frequency Regulation Provision Using Cross-Brand Bidirectional V2G-Enabled Electric Vehicles
SE0106	**Devang Bhatt** and Mohamed El. Darieby	An Assessment of Batteries form Battery Electric Vehicle perspectives
SE0107	Aboelsood Zidan, A. F. Okou, Boubacar Housseini, M. Tarbouchi, D. Bouchard	Incorporating Saturation in Permanent-Magnetic Synchronous Generator Modeling for All-Electric Ship Applications

SE0039	**Farzad Tashtarian**, Ahmadreza Montazerolghaem, Mahmoud Abbasi	Distributed Lifetime Optimization of Wireless Sensor Networks in Smart Grid
SE0014	**Friedrich Wiegel**, Gerald Oberschmidt, Veit Hagenmeyer	Cross-media mesh networks for smart home and smart grid applications
SE0083	Ahmed M. Fatouh, **Omar A. Nasr**, M. M. Eissa	New Semi-Supervised and Active Learning Combination Technique for Non-Intrusive Load Monitoring
SE0096	**Sébastien Mathieu**	Distributed Control of Photovoltaic Units in unbalanced LV Distribution Networks to Prevent Overvoltages

Session 9: Safety and Security of Smart Energy & Grids

Paper ID	Authors	Title
SE0025	**Sirojan Tharmakulasingam**, B.T Phung, E. Ambikairajah	Deep Neural Network based Energy Disaggregation
SE0066	**Shen Wang**, Peng Zhang, Jun Wu, Yutao Zhang	Social Networking and Consumer Preference based Power Peak Reduction for Safe Smart Grid
SE0094	**Ferdinand von Tüllenburg**, Jia Lei Du, Georg Panholzer, Rafael Vidal	Implementation of a Scalable and Robust Messaging Solution for Flexibility Trading
SE0095	Ioannis Poursanidis, **Nikoleta Andreadou**, Evangelos Kotsakis, Marcelo Masera	Evaluation of interoperability in the context of advanced metering infrastructure
SE0098	**Yu-Tso Chen**	Modeling Information Security Threats for Smart Grid Applications by Using Software Engineering and Risk Management
SE0089	**Fundiswa Mthethwa** and John Van Coller	Investigation into the Issues Associated with closing an automated Normally Open (N/O) point on Medium Voltage (MV) Networks where Fault Location, Isolation and Service Restoration (FLISR) tool is planned
SE0090	**Masoud M. Shabestary,** Shahed Mortazavian, Yasser A-R. I. Mohamed	Overview of Voltage Support Strategies in Grid-Connected VSCs under Unbalanced Grid Faults Considering LVRT and HVRT Requirements

Session 10: Micro Energy Grids

Paper ID	Authors	Title
SE0007	**Zhirui Liang**, Zhengxiang Song, Jianhua Wang, Guogang Zhang and Xian Wang	Design and Comparison of Scheduling Schemes for Grid-connected Hybrid PV-Hydrogen-Battery Microgrid
SE0022	**George Daoud**, Hany Selim and Mohamed Abdelraheem	Micro Phasor Measurement Unit Phasor estimation by off-nominal frequency
SE0024-A	**Ahmed Abouarkoub**, Zhen Gao, Mostafa Soliman, Sungbin Suh, and Vincent Perera	An Online Smart MicroGrid Energy Monitoring and Management System
SE3001-A	**Rupp Carriveau**, Lindsay Miler	The Role of Smart Water in the Climate-Led Energy Evolution Network (CLEEN) 2040
SE0028	**Ricardo Siqueira de Carvalho**, Pankaj K. Sen, Lucas Feksa Ramos and Luciane Neves Canha	Communication System Design for an Advanced Metering Infrastructure
SE0104	**Tanveer Iqbal**, Zar Khitab	Energy Management System for Optimal Operation of Microgrids Network
SE0078	**Emmanuel Kobina Payne**, Lu Shulin, Qian Wang, Licheng Wu	Appraisal of Constraints Impeding the Integration of Distributed Energy Resources Network

Conference Location and Directions

UOIT Address: 2000 Simcoe St N, Oshawa, ON L1H 7K4

Map of UOIT

UA 1120 and UA 1220 are located in the science building

Parking Information:

Founder Lot 2 beside ERC building (Paid parking)

Speaker Presentation Abstracts

Dr. Hossam A. Gabbar

Title: Resilient Transportation Infrastructures: Planning, Control, and Performance Optimization

Abstract: This talk will discuss challenges and opportunities to achieve resilient transportation infrastructures. Planning, control, and optimization of transportation technologies and charging stations will be presented, along with hybrid fuel, and integration of renewable energy and energy storage systems, as integrated with regional gas-power grids to meet the mandate of clean transportation infrastructures. Resilient interconnected micro energy grids will be evaluated as part of transportation infrastructures with cost and performance optimization, in view of energy demand and forecasting. New business models with economic analysis will be discussed in view of recent and emerging energy and transportation technologies.

Prof. Miguel F. Anjos

Title: A Tight-and-Cheap Conic Relaxation for the AC Optimal Power Flow Problem

Abstract: The classical alternating current optimal power flow problem is highly nonconvex and generally hard to solve. Convex relaxations, in particular semidefinite, second-order cone, convex quadratic, and linear relaxations, have recently attracted significant interest. The semidefinite relaxation is the strongest among them and is exact for many cases. However, the computational efficiency for solving large-scale semidefinite optimization is lower than for second-order cone optimization. We propose a conic relaxation obtained by combining semidefinite optimization with the reformulation-linearization technique, commonly known as RLT. The proposed relaxation is stronger than the second-order cone relaxation and nearly as tight as the standard semidefinite relaxation. Computational experiments using standard test cases with up to 6515 buses show that the time to solve the new conic relaxation is up to one order of magnitude lower than for the standard semidefinite relaxation. This is joint work with C. Bingane and S. Le Digabel.

Prof. Elna Holmberg

Title: Advancements in Electromobility Research

Abstract: The European Union has set a target to reduce CO2 emissions from the transportation sector by 65% by the year 2050. There are many different alternatives to reach the targets, such as biofuels, electro fuels, battery vehicles, and fuel cell solutions. The best way forward to reach an effective and CO2 low/free transportation sector is still being discussed both within the research community and in the industry. One of the alternatives, to electrify vehicles, has matured faster than many expected and has in the past years received more and more attention.

Prof. Hussein Mouftah

Title: Connected Electric Vehicles in Smart Cities

Abstract: The transformation of our current cities into smarter cities will bring challenges in diverse areas such as the transportation system, the electricity system, and wearable systems, just to name a few. In smart cities, Information and Communication Technologies (ICT) will play a vital role for providing services in the urban environment. These services include real time monitoring and reaction in time through wireless sensor and actuator networks. Smart Grids (SGs), Intelligent Transportation Systems (ITS), Internet of Things (IoT), Electric Vehicles (EVs), and Wireless Sensor Networks (WSNs) will be the building blocks of futuristic smart cities. Smart grid refers to the modernization of traditional power grid by incorporating two-way digital communication support at generation, transmission, and

distribution level. Intelligent transportation system refers to making the vehicular traffic smarter by reducing congestion, optimized fuel consumption, shorter routes, and better safety, self-driving cars by using communication and sensing technologies. Internet of things refer to a world-wide network of interconnected objects uniquely addressable, employing M2M communications, based on standard communication protocols and allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service. IoT can be very useful for resource management in the context of smart cities. Wireless sensor networks are composed of sensor nodes capable of performing sensing and implementing the M2M communications. All these technologies will help to build a smart city. In this presentation we will address technology trends with a focus on connected electric vehicles in smart cities.

Prof. Gerry Moschopoulos

Title: Recent Developments in Power Electronic Inverters for Renewable Energy and Smart Grid Applications

Modern power systems that use renewable energy sources and smart grid technology have been made possible due to advances in power electronic conversion technology. Power electronic converters use power semiconductor devices to convert power from one form to another and thus serve as interfaces in power systems. Developments in power semiconductor devices and power converter topologies have made possible power system architectures and capabilities that have improved performance to an extent that was only dreamt of twenty years ago. This has enabled utilities to cope with ever-increasing demands for electrical power by commercial and residential users and to comply with increasingly stringent environmental regulations that have resulted from concerns about climate change.

The main focus of this presentation will be on recent developments in power electronic inverters that convert DC voltage to AC voltage. Inverters are key building blocks in any modern power system, especially since they are the main interface to the utility grid. Although traditional thyristor-type power converters continue to be used as inverters, there are now a multitude of other options that have found their way in modern power systems.

Topics that will be covered in the presentation include:

- Advances in power semiconductor technology used in inverters
- Low power micro-inverters that maximize modularity in solar energy systems
- Medium power string inverters for solar energy systems
- High power neutral-point connected and modular multi-level inverters for wind energy systems
- Integrated modeling for power electronic based wind-energy systems
- Smart solid-state transformers

Examples from the presenter's research will be given to illustrate key concepts.

Prof. Bala Venkatesh

Title: Energy Storage – Asset Deferral using Pole Top Units

Abstract: Energy Storage is becoming an important aspect of distribution systems. This talk presents a case of pole-top energy storage system. Construction, Test and Performance of the pole-top unit on Toronto Hydro-Electric System Limited is described. Potential for asset upgrade deferral is described.

Prof. Loi Lei Lai

Title: Smart Grid for Smart Cities – A Decision Support System with consideration of Natural Disaster

Abstract: As a result of information technology advancement and its deep integration with the electric power industry, smart grid forms a solid foundation to build smart city. Meanwhile, the construction of

smart city will also greatly stimulate the enormous potential of smart grid. City managers must be fully aware of the potential of the smart grid, so that the smart urban construction can play an important role. It is expected that with the continuous advancement of technology, smart grid and smart city construction will mutually promote and facilitate each other.

Current system defensive method estimates failure risk based on online operation conditions. Preventive control and emergency control measurements need to be stipulated to deal with those failures with high risk and ensure the system can operate steadily after fault clearance. However, the anticipated faults in the current risk assessment are in accordance with fixed average failure rate obtained by off-line historical data statistical analysis. Power system malfunctions are mainly from component defect, manual mistake, unreasonable operation mode and natural disasters. The first three factors have fixed failure rate and can be obtained by off-line historical data statistical analysis. Natural disasters have prominent spatial and temporal distribution features. Using fixed rate can cause large statistical error.

The selection of data mining technology to analyze the mass amount of data from smart grid to support decision-making for the government to effectively reduce operating costs and improve operational efficiency of smart city will be one of the big issues. Data exchange platform gathers all information from EMS, weather forecasting, wildfire monitoring, icing monitoring and lighting orientation monitoring systems, and send the information to data integration module. After data integration, preprocessing and checking, the processed data is send to analyzing and warning module and control and decision-making module for assessment. Finally, the result will be shown in environment and power network information display module. Some initial results will be discussed. Sources of Big Data in Smart Grid will be considered. Different methods for data analytics will be investigated.

Prof. Bingyin Xu

Title: A Novel Control Method for Isolated Micro Grids Based on Synchronized Fixed-Frequency Current Source

Abstract: A novel control method for inverters based isolated micro grids is proposed. The inverters inject fixed-frequency currents whose phase angles are synchronized using an universal time signal provided by GPS. The magnitudes of the currents are determined by voltage-current droop control characteristic.

Prof. Mohamed Safiuddin

Title: A Blueprint for Engineering Education in the 21st Century

Abstract: It is an established fact that the overall welfare of any society directly depends upon the level of contribution and productivity of each of its members. In modern times, however, it has also become clear that the engineering know-how of a society further amplifies the productivity of its other members trough innovation and technology. Therefore, contributions of engineers are, the backbone of an economy in today's complex world. However, in a closed loop system in which technological advancements trigger complexities of life in social patterns which, in turn, requires technological tools to cope with them, we find that a graduate engineer's period of active participation in the professional life keeps shrinking. There are a few in the profession who, by genius and innovation, keep advancing the frontiers of technology while the majority left behind, find it difficult to cope with. At the same time over the last couple of decades, we have witnessed that technological revolutions in information processing, computing, communications and AI [Artificial Intelligence] have turned geo-political boundaries in to lines in the sand. As educators, the challenges we face now are not only the initial education at the Bachelor's degree level, in a given geopolitical confine, but also to design an education system for life-long productivity of engineers within a global framework. Since engineering is application of scientific knowledge to solve societies' real-life problems, hands-on education and training is essential in this

profession. Though in this respect it parallels the medical and legal profession, the education system of engineers does not come close to the education system of doctors and lawyers.

This paper, using a systems approach, presents life-long engineering education as a multi-loop control system with the student engineer as the "plant" and the four institutions as the controllers and feedback elements, as portrayed in the block diagram [Figure 3]. These four institutions being: The Government, The Professional Society, The University and, The Industry. After introduction, a set of roles and responsibilities of these institutions are developed based on this model. Multi-institutional approach to the process of engineering education is covered in the following section with couple of case studies. Then role of IT and communication technologies as tools of distance education are described followed by some recommendations.

Prof. Huimin Li

Title: IEC61850 Based Open Platform for Smart Grid Application Development

Abstract: This research proposes an IEC61850 based open platform, which allows modular, standard based and efficient application development for smart grid applications, such as smart grid control, protection and monitoring. The research provides a hardware platform and application interface (API) with IEC61850 modelling for logical nodes common for application development. In addition, it describes the engineering tools and processes necessary to successfully design, implement and operate the smart grid system built upon the open platform.

Prof. Katherine Sparkes

Title: Distributed Energy Resources: Challenges and Opportunities for Ontario

Abstract:

- Evolution of distributed energy resources (DERs)
- Challenges and opportunities that DER development present to the IESO as the bulk system operator
- Overview of work the IESO is doing to understand and address barriers to DER integration in Ontario markets/electricity system
- Removing barriers to DERs/new technologies to provide necessary grid-level electricity services Storage Microgrids
- How Ontario compares to other jurisdictions in terms of innovation in its electricity sector (in support of reliability, affordability, community choice, sustainability)

Prof. Dan Ruby

Title: OCE's Advanced Technology Platforms: Autonomous Vehicle Innovation Network (AVIN), IBM Innovation Incubator Project, and Next Generation Network Program

Abstract: OCE's Advanced Technology Platforms including:

- Autonomous Vehicle Innovation Network (AVIN)
- IBM Innovation Incubator Project
- Next Generation Network Program

Stephen Brown

Title: Cybersecurity Considerations for Industrial IoT (IIoT)

Abstract: In 2020, at least 50 billion devices will be connected to the Internet, a significant share of the them will be in the future production process. Equipped with sensors and actors, machines see you and shape the decision making process to better serve you. This talk will address innovations and emerging technologies for Industrial Internet of Things (IIoT).

Author Presentation Abstracts

Session 1：Power Electronics Technology and Applications

Venue: Room UA1220
Chair: Xianke Lin
UOIT
Time: 13:15pm-15:35pm

Note:
* Session photo will be taken at the end of the session.
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SE0032 Time: 13:15pm-13:35pm	Stabilizing Integrated Power Systems with Constant Power Loads Based on DC Bus Voltage Monitoring **Zhi Qu**, Seyyedmilad Ebrahimi, Navid Amiri, Juri Jatskevich *The University of British Columbia (UBC), Canada*

Abstract: Tightly regulated fast electronic loads are known to behave like constant-power loads (CPLs) and exhibit negative incremental impedance. CPLs can be found in many applications such as power systems of aircraft, ships, vehicles, etc. While each CPL has its own controller, the stability of the entire integrated power system might not be guaranteed due to the CPL's destabilizing effect. In this paper, an adaptive method is proposed to stabilize the integrated power system by monitoring the DC bus voltage and enabling an active damping circuit depending on the situation. The performance of the proposed methodology is verified using a simplified model of a typical integrated power system consisting of two sources and CPLs under different loading conditions.

SE0093 Time: 13:35pm-13:55pm	Forecasting and Evaluation Electricity Loss in Thailand via Flower Pollination Extreme Learning Machine Model **Sarunyoo Boriratrit**, Wachira Tepsiri, Arthitaya Krobnopparat, Nongnooch Khunsaeng *Provincial Electricity Authority, Thailand*

Abstract: In many developed countries analyzed and evaluated Loss electricity by using Machine Learning to improve the best solution in forecasting. In Thailand, Provincial Electricity Authority was analyzed in both of technical loss and non-technical loss to handle the critical situation which could be consequences. In this research, Loss electricity forecasting was studied and analyzed with Machine Learning and Evolutionary Computational for high accuracy when forecasting by using Extreme Learning Machine merged with Flower Pollination Algorithm to find the best solution and use in the real-world. Experiment results show that average of Root Mean Square Error of the proposed model compared with actual data of North, Northeast, Center and South loss electricity datasets from November to December 2017 were 0.5963.

SE0043-A Time: 13:55pm-14:15pm	Load Frequency control of power systems using a Hierarchical structure of Model Predictive control and Discrete Sliding Mode Control **Abdolreza Dehghani Tafti** *Islamic Azad University, Karaj Branch, Karaj, Iran*

Abstract: The problem of Load Frequency Control (LFC), which is the frequency regulation of a power system, with considering uncertainties and nonlinearities is a complicated problem in design and operation of power systems. In this paper, a hierarchical/cascade structure of Model Predictive Control (MPC) and Discrete Sliding Mode Control (DSMC) is proposed to solve this problem. The DSMC, which is able to reject uncertainties in nonlinear systems, is used in inner control loop, and the MPC, as an optimal control solution while fulfilling the constraints on the basis of a suitable predictor of the plant behavior, is used as outer loop control to generate reference for inner loop. Simulation results demonstrate the proposed control structure has a robust performance against the modeling uncertainties and external disturbance affecting the power system without more computational burden and simplicity for implementation on digital processors.

SE0006 Time: 14:15pm-14:35pm	Simulation of Line-Commutated Rectifier Systems Using Fixed Time-Step Without Zero-Crossing Events **Zhi Qu** *University of British Columbia, Canada*

Abstract: Line-commutated rectifiers (LCRs) are widely used in many industrial applications and electronic loads. For analysis and simulation of power systems that include many switching converters, numerically efficient and accurate models of rectifiers are needed. The detailed switching models of LCRs in traditional electromagnetic transient (EMT) simulation programs (either state-variable-based or EMTP-type) require special handling of switching events (i.e., interpolation and/or use of small time-steps for zero crossing detection), which results in increased computational complexity. This paper

presents the recently developed generalized parametric average-value model (GPAVM) of LCRs that is capable of predicting the ac harmonics of interest with good accuracy while using fairly large fixed time-steps without the need for handling the zero-crossing events. This feature represents an advantage over the established methods and may be utilized for more efficient simulation of power systems with many rectifier loads.

SE0086 Time: 14:35pm-15:55pm	Dynamic Analysis and Improved Control Design of a Grid-Connected Converter with Flexible Multi-Sequence Reactive Current Injection **Shahed Mortazavian**, Yasser Abdel-Rady I. Mohamed *ECE Department, University of Alberta, Edmonton, Canada*

Abstract: The recently developed grid codes suggest the injection of a flexible positive- and negative-sequence reactive current components proportional to the magnitude of the voltage dip to help the power system ride through the unsymmetrical faults. However, to the best of the authors' knowledge, the detailed dynamic analysis of the grid-connected converter dynamics with the flexible positive- and negative-sequence current injection function considering the impact of the grid strength and the converter control parameters are not reported in the literature. To fill in this gap, first, a linear model of the augmented nonlinear system dynamics is developed and the small-signal stability analysis is performed on the system dynamic behaviour. Second, a new and effective model-based controller parameters design method is proposed to maintain the system stability during and after the fault with the consideration of the mutual interaction among different system controllers. Time-domain simulations validate the accuracy and the effectiveness of the developed method.

SE0001 Time: 15:55pm-15:15pm	Evaluating Possible Privatization Schemes for Power Generation Sector in Saudi Arabia Hussien Adel, **Ahmed S. Alahmed** and Ibrahim Elamin *King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia*

Abstract: The fact that electrical energy is not a public service, but a commercial commodity that can be traded in a competitive market is very crucial towards the process of deregulating the market. The restructuring of the generation plants will assist in creating a perfect and fair competition between different companies and thus boosting the economy of the country by attracting new investors. The energy sector in Saudi Arabia is currently on the verge of a pivotal alterations and reforms in regulatory and investment policies. The kingdom is planning to shift the electricity market from a total monopoly where the generation, transmission and distribution sectors are almost owned by one entity to a more deregulated market especially on the generation side. This paper will provide a novel method to assess Saudi Arabia in evaluating the pricing structure of the existing power plants. Real data from the current installed plants will be used, ensuring more pricing accuracy. The paucity of research in the field and the reliance on forecast data of contemporary literature would enhance the value of the outcome of this article and ultimately help Saudi Arabia and other developing countries to successfully embark on the

new phase of the electric grid.

SE0067 Time: 15:15pm-15:35pm	Impact of Demand Response on Short-term Generation Planning Nooriya A. Mohammed and **Mohammed H. Albadi** *Sultan Qaboos University, Oman*

Abstract: Recent research on demand management has focused on the development and innovation of various means to control consumer behaviour in order to achieve a balance between supply and demand with minimum cost. Previous research focused on stimulating the consumer response to market prices in order to rationalize consumption, especially during peak periods. This study addresses the impact of consumer response on supplier decisions of generation in short-term planning. The results highlight the effect of high consumer response rate on electricity price changes and production planning from different technologies including base-load and peak load generation technologies.

Session 2：Information Systems and Communications

Venue: Room UA1120
Chair: Ruth Milman
UOIT
Time: 13:15pm-15:35pm

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SE0026 Time: 13:15pm-13:35pm	A Novel Framework Short-Term Load Forecasting for Micro-Grid Energy Management System **Wen-Chi Kuo**, Ting-Yen Hsieh, Hsing-Chih Chen, Chang-Liang Chi and Yung-Fu Huang *Industrial Technology Research Institute, Hsinchu, Taiwan*

Abstract: Short-term Electricity Load forecasting (STLF) is one of the most important technologies for Energy Management System (EMS) in various aspects, such as peak-load shaving application, demand response, or net-zero energy technology. This paper presented a novel Short-term Electricity Load forecasting (STLF) framework with four strategies— a Variable selection of input parameters processing method, Modified Time Series - Exponential Smoothing model, Peak-load, and Temperature correction factors. The testing results showed that the proposed framework of forecasting indeed improves the accuracy of day-ahead STLF, especially on the cases with limited historical information and data loss conditions.

SE0057 Time: 13:35pm-13:55pm	Mitigation of Blackhole attacks and wormhole attacks in wireless Sensor networks using AODV protocol **Taranpreet Kaur** and Rajeev Kumar *Punjab Technical University, Jalandhar, Punjab, India*

Abstract: The Denial of service is a well-known security concern in wireless sensor networks. Although ZigBee protocol is designed by considering the security and lower battery consumption, still wireless sensor networks are vulnerable to so many denials of service attack, especially when nodes are deployed in the unattended environment. The attacker utilizes the vulnerabilities to launch, many Denial of Service

Attacks in wireless sensor networks. In this paper, various approaches to defend from Denial of service attacks are described and an approach for detection and defending from both black-hole attack and worm-hole attack is proposed. The proposed methodology is less complex and easy to implement, also consumes less battery power, hence enhances network lifetime.

SE0058 Time: 13:55pm-14:15pm	Review of Different Encryptionand Decryption Techniques Used for Security and Privacy of IoT in Different Applications **Rashid Hussain** and Irfan Abdullah *Hamdard University, Pakistan*

Abstract: Internet of Things (IoT) allows different devices connected to global network or Internet for desired application. This emerging trend of Internet of Things have been developing with exponential rate since last two decades and where different technologies and protocol stacks have been introduced in market. While developing different techniques of integration of smart devices we are facing security and privacy issues of data. To cope up with these issues different techniques have been introduced to overcome this problem. In this research paper we provide the survey of different techniques and technologies used to provide reliable and secure data communications. This research paper will focus on encryption and decryption techniques used in IoT.

SE0113 Time: 14:15pm-14:35pm	Clean Technology: An Eagle-Eye Review on the Emerging Development Trends by Application of IOT Devices **Navpreet Kaur** and Inderdeep Kaur Aulakh *UIET, Panjab University, India*

Abstract: Internet of Things (IoT) is defined as a clustered network, which provides communication amongst the number of physical devices, sensors, actuators and embedded systems. It is often referred as smart devices because of its unique properties to capture, sense, storage and transfer the user required information from the surrounding. The applications of IoT is increased rapidly due to digitization, and a huge amount of data is transferred amongst the number of devices which results in creating a requirement of massive energy. Green IoT is found to be a solution for energy crisis and deployment of green IoT techniques acts as a challenging task because of the larger scale and complexity. In this research, an overview of green IoT along with different techniques deployed by many authors in the field of real-time environment will be ascertained. Initially, more concentration is given to address IoT, challenges faced regarding development and effects of excessive energy usage along with its applications. Further, the concept of green IoT is introduced, and different authors review on the deployment of green IoT in terms of design, data centres, and transmission of data through sensors will be ascertained in this research. The different authors review on several hardware models and strategies developed in terms of green IoT will be explained and the study on result obtained shows that there is an improvement in the field of communication, energy transfer and consumption, transport and society compared to individual IoT

systems.

SE0016 Time: 14:35pm-14:55pm	Time Domain Voltage Unbalance Index Based on Second Order Voltage Tensor Theory **Moises Henriques** and Jorge Cormane *University of Brasilia, Brasilia, Brazil*

Abstract: This paper proposes an alternative index capable of evaluate voltage unbalance in time domain. The proposed index it's called voltage unbalance level (VUL) and makes use of the second order voltage tensor theory in order to assess voltage unbalance. A correlation between VUL and the voltage unbalance factor (VUF) is exposed for unbalances on magnitude and phase angle. The mathematical foundations of this theory and a behavior analysis of both indexes are also presented in this study.

SE0099 Time: 14:55pm-15:15pm	Mobile Agents for Route Planning in Internet of Things using Markov Decision Process Shamim Yousefi, **Farnaz Derakhshan**, and Ayub Bokani *University of Tabriz, Tabriz, Iran*

Abstract: Using mobile agents for data aggregation in ad-hoc networks is a promising approach and gains more popularity every day. However, these agents need an efficient rout planning to optimize the quality of service (QoS) which is a very challenging task in such uncertain environment. Numerous previous works have presented different schemes for route planning of mobile agents in wireless sensor networks. Similarly, some other approaches have proposed the use of mobile agents for data aggregation in the Internet of Things (IoT). However, current approaches for route planning of mobile agents do not satisfy the requirements of the internet of things, due to the mobile and heterogeneous IoT nodes. In this paper, we propose an intelligent rout planning that enables mobile agents in IoT systems to make the best decision for selecting the next node in different moments. We use Markov Decision Process (MDP) as the underlying optimization model, which is well-known on its effectiveness to optimize decision making under uncertainty. In this model, we consider the distance between the nodes from each other, the distance between the nodes and the sink, residual energy of the nodes and the priority of them as the MDP parameters. Our proposed method could improve the energy consumption of IoT nodes and the life time of the system. Furthermore, our proposed method tries to maximize the reliability of the network and enhances data transmission delay.

SE0103 Time: 15:15pm-15:35pm	An Agent Based Approach For Assignment Of Virtual Networks To Substrate Network For Software Defined Networking Ali Akbar Nasiri and **Farnaz Derakhshan**

	University of Tabriz, Tabriz, Iran

Abstract: Virtual Networking and Software Defined Networking are two interesting topics for researchers which have many challenges, particularly when it is desired to embed virtual networks for software defined networks. In one hand, virtual network embedding (VNE) is known as a non-deterministic polynomial-time hard (NP-hard) problem. In the other hand, Software-Defined Networking (SDN) needs to address new solutions for the consideration of its central controller in the process of assigning virtual networks to physical resources. Therefore, the aim of this paper is to address the challenge of embedding VNs to the physical network for SDNs, followed by providing a solution.

In this paper, we present our new approach for virtual network embedding problem in a distributed manner for SDNs. To do so, we used the techniques of multiagent systems, as a well-known pattern for distributed systems. A virtual network mapping protocol is proposed to communicate messages between agent-based substrate nodes. We also present a new distributed algorithm which is responsible for load balancing and mapping virtual nodes to substrate nodes, and for virtual links to substrate links. This algorithm minimizes the delays of controller-to-switch.

Session 3：Smart Grid Design and Operations

Venue: Room UA1220
Chair: Loi Lei Lai
Guangdong University of Technology
Time: 16:00pm-18:20pm

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SE0029 Time: 16:00pm-16:20pm	Effects of Centralized Battery Storage Placement in Low-Voltage Residential Distribution Networks with High Photovoltaic Penetration **Muhammad Rashid** and Andrew Knight *University of Calgary, Canada*

Abstract: In this paper, power flow simulation is used to investigate how centralized battery storage can aide in mitigating under-voltage conditions in highly PV penetrated residential network. It also investigates how the placement of the battery storage relates to the rating of the storage used. It is found the reduction in storage rating is quadratically proportional to the distance along the low-voltage distribution feeder..

SE0079 Time: 16:20pm-16:40pm	Design Concept of Thermal Behavior Condition Monitoring of Distributed Energy Resources Network System with ZigBee and GSM Technology in Remote and Rural Areas **Emmanuel Kobina Payne**, Lu Shulin, Qian Wang, Licheng Wu *Jiangsu University, China*

Abstract: This paper is presented as a proposal to improve distributed energy resources (DERs) network condition performance through system state data monitoring and prompting. Monitoring thermal behavior of DERs network is to explore the dualism between heat effect and Electrical power flow phenomena. This is crucial to determine the dynamic rating of the system's ability to perform according to the designed current carrying capacity. It will minimize constraints development due to thermal effect in

distribution networks, and improve demand side response. System operators are been informed of adverse thermal behavior through ZigBee and GSM configured technology. LM35 temperature sensors are employed to sense the temperatures of distribution cables, thermal condition of storage facilities, protection control devices and that of Solar PV irradiation and Wind power turbine. The outputs are then fed into the input of ATMEGA328P microcontroller for further processing. The performance information are picked, coordinated and transmitted through ZigBee and GSM platform, and further displayed on LCD screen under normal condition. When any of the thermal parameters anticipate abnormal condition, the sensor communicates with the microcontroller to trigger an alarm of the impending condition. This will send a GSM activation SMS text to the remote monitor to alert operators. NI Multisim software is used for development of the Electrical circuit. The proposed design concept will serve as a predictive system tool to remotely assess the condition of DERs for Microgrid application to mitigate power flow losses being caused by network system components thermal behavior.

SE0080	Pulse Position modulation based Energy Detection for Smart Grid Communication
Time: 16:40pm-17:00pm	**Haroon Rasheed**, Farah Haroon and Nandana Rajatheva *Bahria University, Karachi, Pakistan*

Abstract: Smart Grid Network (SGN) concept is developed for dynamically and automatically respond to changes in power grid conditions, which will require sensors to provide detection of signal for real-time information and status. The most distinguishing attribute of Pulse Position Modulation (PPM) in SG Communications is its non-coherent detection. It avoids complex channel estimation which becomes a very complicated process due to very large bandwidth and fine time resolution with large number of multipath components. In this paper, we analyze PPM based energy detection for sensing in smart grid networks where intelligent devices for power monitoring, smart sensors and smart meters for Home Area Network (HAN) or Neighborhood Area Network (NAN) can start transmission at any time. In contrast to well-known case of Additive White Gaussian Noise (AWGN) channel, we further extended our investigation to K_G composite model and the effect of fading and shadowing severity is discussed extensively. Reduction in either the fading index m or shadowing parameter m_0 influences the channel characteristics and declines the error performance. Hence, the presented results furnish guidelines for energy detection based sensing of PPM modulated signal for SGN various communication models.

SE0087	Design and Implementation of an Internet of Things Based Smart Energy Metering
Time: 17:00pm-17:20pm	Mohammad Hossein Yaghmaee and **Hossein Hejazi** *Mashhad Electrical Energy Distribution Company (MEEDC), Mashhad, Iran*

Abstract: Internet of Things (IoT) can be used to furnish intelligent management of energy distribution and consumption in heterogeneous circumstances. In the recent years, by the growth of IoT and digital technologies, smart grid has been becoming smarter than before. The future power grid needs to be implemented in a distributed topology that can dynamically absorb different energy sources. IoT can be utilized for various applications of the smart grid including distributed power plant monitoring, power generation and consumption prediction, power consumption monitoring, energy storage monitoring, smart meter, electric vehicle charging, power demand side management and various area of energy production.

In this paper, by using the IoT capabilities, we have designed and implemented a smart energy metering platform consisting of smart plugs, gateway and cloud server.

SE0091 Time: 17:20pm-17:40pm	Using DDS Based on Unified Data Model to Improve Interoperability of Smart Grids **Alaa Alaerjan**, Dae-Kyoo Kim, Hua Ming, and Khalid Malik *Oakland University, USA*

Abstract: The connectivity of power domains is a key factor for realizing a smart grid. Different power domains in smart grid (SG) involves various types of applications and devices each of which comes with its own requirements. In addition, different communication protocols and data models have been already proposed to address those requirements. Due to the differences in communication technologies, interoperability challenges have been raised in SG. Interoperability issues not only deteriorate the connectivity of different domains, but also compromise the potentials of data sharing in SG. The Data Distribution Service (DDS) has emerged as a possible solution since it supports different features such as transport configuration and dynamic discovery mechanism. In this paper, we describe how DDS can be used to address both data interoperability and protocol interoperability in SG. We first describe interoperability issues in SG and then describe the use of a unified data model with DDS and configuring DDS for TCP/IP and UDP/IP. We also implement the configurations and present the results of the implementations for comparative analysis.

SE0035 Time: 17:40pm-18:00pm	Fair Billing Mechanism for Energy Consumption Scheduling with User Deviation in the Smart Grid **Prasertsak Charoen**, Marios Sioutis, Saher Javaid, Yuto Lim and Yasuo Tan *Japan Advanced Institute of Science and Technology, Ishikawa, Japan*

Abstract: In the future smart grid, Demand Side Management (DSM) will be one of the key technologies to facilitate utility companies and customers in order to achieve system optimality such as minimizing energy cost and peak-to-average ratio. While most of the prior works in the literature have reported good results in achieving system optimality, they mostly ignore considering the aspect of system fairness, especially in regards to the electricity bills of the users. More specifically previous works do not address the important problem of users' commitment and their actual consumption level when calculating the payments. In this paper, we tackle this problem and design an alternative fair billing mechanism that assures the system fairness. The proposed billing considers not only real-time consumption information of the grid but also the energy consumption level of each user. Thus, each user's bill will be adjusted based on their commitment and contribution to the system. Simulation results show that the proposed billing mechanism ensures fairness in users' payments.

SE0063 Time: 18:80pm-18:20pm	Ant Colony Cleaning Behavior Algorithm based Multicast for SDN in Smart Grid **Jun Wu**, Peng Zhang, Jianhua Li, Zeyang Liu

	Shanghai Jiao Tong University, Shanghai, China

Abstract: Currently, software-defined networks (SDN) are regarded as the development trend of novel smart grid. Multicast is a network technology that allows one or more senders (multicast sources) to send a single packet to multiple recipients. As reliable communications are required by many SDN services and applications, reliable and efficient multicast is a must when the control plane of SDN performs the forwarding services. Although there are some existing multicast schemes, efficient and smart multicast scheme for SDN is still an open issue because of the dynamic, openness and virtualization. Meanwhile, ant colony algorithm has been proven to be a feasible approach to perform cluster in networks. In this paper, an ant colony cleaning behavior algorithm based multicast scheme is proposed for SDN. In the proposed scheme, ant colony cleaning behavior based cluster approach is proposed. Moreover, cluster driven multicast is realized. Also, the implementation system of the multicast scheme is designed in SDN controller. The simulations show the advantages of the proposed scheme.

Session 4：Energy Consumption and Management

Venue: Room UA1120
Chair: Prasant Ghosh
Syracuse University
Time: 16:00pm-18:20pm

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SE0068	A Mathematical Model for the Aggregated Power Consumptions of Air Conditioners
Time: 16:00pm-16:20pm	**Pegah Yazdkhasti,** Chris P. Diduch *University of New Brunswick, Canada*

Abstract: Use of renewable resources such as wind and solar energy are increasing. However, the intermittency of these resources make it difficult to integrate with the grid. Direct load control is one method to mitigate the variability of the generation side by managing the demand-side. Residential air conditioners can play an important role for this purpose. This paper presents a novel second-order model for the aggregated power consumption of the air conditioners for two input variables, the ambient temperature, and the thermostat set point. This paper also presents a sensitivity analysis of the proposed system regarding the mean value of the thermal capacitance of the air-conditioned rooms. The performance of the proposed model was compared with the numerical simulation of a population of air conditioners in various conditions of changing the ambient temperature and thermostat set points. Simulation results show that the proposed mathematical model can precisely follow the aggregated load profile of the air conditioners.

SE0074	A Class of Optimal and Robust Controller Design for Energy Routers in Energy Internet
Time: 16:20pm-16:40pm	**Chuantong Hao**, Haochen Hua, Yuchao Qin and Junwei Cao *Tsinghua University, China*

Abstract: In this paper, a class of optimal and robust controller is designed for a typical energy router (ER) within the scenario of an energy Internet (EI) from the control perspective. As the core element of the EI, the considered ER is assumed to have access with photovoltaic (PV) units, wind turbine generators (WTGs), micro-turbines (MTs), fuel cells (FCs), battery energy storage (BES) devices, super capacities (SCs), loads and other ERs. Two control objectives are considered as follows. 1) Since

the access of large-scale renewable energy sources (RESs) would lead to excessive DC bus voltage deviation within the ER system, a desired controller shall regulate the voltage deviation effectively. 2) According to the operational principle of EI, when multiple ERs are interconnected, an autonomous power balance of each ER is expected to be achieved with priority. Then the optimal energy dispatch problem shall be considered. When both two problems are considered simultaneously, a mixed robust $\boldsymbol{H_2/H_\infty}$ control problem is formulated and is solved analytically. Simulations show the usefulness and effectiveness of the proposed scheme.

SE3003 Time: 16:40pm-17:00pm	Hybrid Islanding Detection for AC/DC Network Using DC-link Voltage Fatemeh Ghalavand, **Ibrahim Al-Omari,** Hossine Kazemi Karegar, Hadis Karimipour *University of Guelph, Canada*

Abstract: Islanding is a critical and unsafe condition which may cause serious problems for smart grid operation. This paper proposes a new method for islanding detection in hybrid AC/DC network from DC side. The proposed method uses variation in energy production and energy storage in DC-link voltage for DC islanding detection. The proposed method is applied on a AC/DC microgrid including Photovoltaic (PV) modules, Combined Heat and Power (CHP) generation units. Simulation results under various disturbance caused by AC fault short circuits, and motor starting verify the accuracy and efficiency of the proposed method.

SE0053-A Time: 17:00pm-17:20pm	A Real-Time daily Price Suggestions in the Smart Grid through stochastic approximation **Asm Ashraf Mahmud** and Paul Sant *University of Bedfordshire, UK*

Abstract: The Smart Grid is a high tech future grid. Currently, we are experiencing outdated power grid which has been developed in hundred years back. Moreover, a smart grid is a bi-directional grid which can resolve so many issues. Presently, energy users are not fairly treated in flat rate pricing mechanism in the current state of power grid. Therefore, there is a room for research in the power Grid in its demand response, particularly in pricing. To resolve the issues, the research deploys a Real-Time daily Price Suggestions model. It is a demand response pricing model between the energy suppliers and users. Both energy suppliers and users are looking to reduce their cost. Although, it's a challenging part of the smart grid. We need a model which can benefit both. Subsequently, this research employs a demand response pricing model by using real-time energy usages data. It has been developed with a set of embedded algorithms. It has two core units like price suggestion unit and price control unit that are connected to the smart meter and also to the main power generation grid. The research utilises the experimental methodology by using simulation technique.

This model generates daily basis real-time suggestions for the users based on their threshold usages by using simultaneous perturbation stochastic approximation method. This research counts only twenty percent random responses from users. The result shows that energy users reduced their bill significantly and energy providers also tremendously reduced their industrial cost because of reduced peak to average ratio. This model is validated by developing a hardware prototype. It addresses the

users' preferences. The model also benefits the non-responsive users. After all, all users achieved the reduced bill regarding traditional flat rate price.

SE0115 Time: 17:20pm-17:40pm	Regularized LSTM based Deep Learning Model: First Step Towards Real-Time Non-Intrusive Load Monitoring **Hasan Rafiq**, Hengxu Zhang, Huimin Li, Manesh Kumar Ochani *Shandong University, China*

Abstract: Residential and commercial buildings consume more electricity than any other sector. Thus, energy saving through smart electrification in those buildings is the best way to reduce overall energy demand. Smart electrification includes end-use appliance energy consumption monitoring in real-time, which can be achieved through Non-Intrusive Load Monitoring (NILM). Recently, deep learning algorithms have been introduced for energy disaggregation but their effectiveness in real-time appliance load monitoring is questionable. In this paper, we have presented two deep recurrent neural networks models: LSTM and GRU. We have introduced regularization to improve our proposed model's performance and have tested them on unseen buildings during training. We have achieved promising results with proposed Regularized LSTM model in terms of accuracy, f1 score and mean absolute error. These results suggest using this model in real-time energy disaggregation of end-use appliances.

SE3004 Time: 17:40pm-18:00pm	Coordinated Fuzzy Controller for Dynamic Stability Improvement in Multi-Machine Power System Majid Dehghani, **Wenyu Han**, Hadis Karimipour *University of Guelph, Canada*

Abstract: Due to the increased deployment of new technologies such as renewable sources and smart meters, complex and unexpected interactions are occurring in power systems. The dynamic instability in power systems are caused by the existing imbalance between mechanical input and output power. For damping these oscillations, power system stabilizer (PSS), and static synchronous compensator (STATCOM) can be used. In this paper, a unique fuzzy controller for dynamic stability of PSS and STATCOM in multi-machine power system is designed. Particle swarm optimization (PSO) combined with genetic algorithm (GA) is used for fuzzy controller optimization. Proposed method is tested on IEEE 39-bus system under disturbance. The simulation results verify the efficiency of the proposed method for dynamic stability of power system.

SE0019 Time: 18:00pm-18:20pm	A new Energy Aware Cluster Based Multi-hop Energy Efficient routing protocol for Wireless Sensor Networks **Amanjot Singh Toor** and A. K. Jain *Dr. B.R. Ambedkar National Institute of Technology, Jalandhar, Punjab, India*

Abstract: The area of Wireless Sensor Networks (WSNs) is an invented automation which is used in recent years to perform multiple tasks in various domains intelligently. The unbalanced energy dissipation of Sensor Nodes results in the significant reduction of network lifetime which is the main problem in WSNs. Cluster based routing plays an inherent role in overcoming the energy dissipation problem and enhancing their network lifetime. In this paper, a new Energy Aware Cluster Based Multi-hop (EACBM) routing protocol for heterogeneous networks has been proposed which uses both the concept of clustering and multi-hop communication to reduce the energy consumption of SNs. Also Sub-clustering concept is used for those SNs which are not included in any cluster or which are out of the reach of CH. This protocol is implemented and compared with the existing routing protocols (SEP, LEACH, CEEC and LEFCA) in MATLAB and found that it outperforms in terms of stability, network lifetime and gives the better solution for energy efficiency in hierarchical heterogeneous WSNs.

Session 5：Materials and Energy Engineering

Venue: Room UA1220
Chair: Liliana Trevani
UOIT
Time: 13:15pm-14:55pm

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SE10001 Time: 13:15pm-13:35pm	Erosion Behaviour Of Hydroturbine Material Under Air Jet Erosion Tester Using D-Gun Coating **Dipender Kumar Dev** *Desh Bhagat Foundation Group of Institutions, India*

Abstract: This paper is concerned with the experiment investigation into erosion behavior of D-gun coated hydro turbine blade material using Air Jet Erosion Tester. The two type of powder coating on alloy steel (CA6nm) used are Al_2O_3-13%TiO_2 and Cr_3C_2–25NiCr with the help of Thermal Spray Technique to improve the mechanical property of Alloy steel (CA6NM).The Present study describes and compares the mechanical and erosion properties of Al_2O_3-13%TiO_2 and Cr_3C_2–25NiCr . D-sprayed coatings deposited on substrate (CA6NM). Experiments using Air Jet Erosion is performed in order to evaluate erosion properties of coated and uncoated tested sample under Air Jet Erosion Tester was characterized under SEM and EDAX. Cumulative weight loss and volume loss is found of coated as well as uncoated samples under Air Jet Erosion at 45°, 60°, 90°. The result of weight loss & volume loss is discussed and compared. It is concluded Cr_3C_2–25NiCr coating is good erosion resistant with CA6NM using Detonation spray process..

SE0013 Time: 13:35pm-13:55pm	District Heating Energy Generation Optimisation Considering Thermal Storage **Jonathan Reynolds**, Muhammad Waseem Ahmad, Yacine Rezgui *Cardiff University, UK*

Abstract: Modern, decentralised, multi-energy vector districts have great potential to reduce energy consumption and emissions. However, due to the complex nature of these systems, they require intelligent management to maximise their benefit. Therefore, this paper models the energy generation of a district heating plant for the purpose of hourly, operational optimisation. Crucially, non-linear,

part-load efficiency curves, and minimum load percentages are included in the energy generation modelling as well as thermal energy storage. Due to the non-linearities, a genetic algorithm, optimisation approach was utilised. The optimisation framework was applied to a case study district with three distinct thermal energy generation sources, a gas CHP, gas boilers, and biomass boilers. The optimisation controlled the load percentage of each technology as well as varying thermal storage capacity to minimise the cost of meeting the heat demand. The study found that compared to the current, rule-based approach, the optimisation achieved a significant cost saving of 12.7% without any thermal storage. As the thermal storage capacity was increased the potential cost saving was also shown to increase proportionally to 22.6% with 1000 kWh of storage.

SE0030	A Memory-Hard Blockchain Protocol
Time:	**Sui Cheng**, Sian-Jheng Lin
13:55pm-14:15pm	*University of Science and Technology of China, China*

Abstract: Bitcoins cryptocurrency is a decentralized digital currency released as open-source software in 2009. In these 9 years of development, the mining devices are changed from the public CPUs into a professional ASICs. The ASICs is a application-specific integrated circuit, which is designed exclusively for mining. Because of its outstanding computing power, the ASICs gradually replaced other devices and monopolies the Bitcoin market. In this paper, we propose a new blockchain chain protocol, which allows us to adjust the loading time of the mining process. This strategy reduces the ASIC and CPU mining rate of the gap. So that the using of ASIC mining is limited. Finally, we analyzed the safety of this new chain structure and compared it to the original chain protocol.

SE1006	The effects of clean energy development on china’s carbon dioxide emission control
Time:	**Enbang Wu**
14:15pm-14:35pm	*Chongqing Yucai Senior High School, China*

Abstract: Climate change is becoming an acute global issue that should be taken seriously by all human beings instead of ignoring it. China, as the world's largest CO2 emitter, its move is vital for the world to deal with the climate change issue. In order to tackle this issue, China announced its Intended Nationally Determined Contributions (INDCs) stating the objective of peaking its CO2 emissions by 2030 while making its best efforts to achieve an earlier peak. To achieve this, various carbon reduction actions need to be implemented and their priority and effects are worth studying. This paper employed a bottom-up modeling approach to examine how different technologies in both the end-use sector and energy supply sector will affect China's future carbon dioxide emissions' trends and in what priority we should deploy them. Results indicated the development of clean energy supply technologies are of great importance to achieve China's carbon reduction goal and should be prioritized. Some other technologies that could potentially contribute to carbon mitigation were also discussed and their impacts were analyzed.

SE0049 Time: 14:35pm-14:55pm	Nonlinear Capacitors Power Dissipation and its Graphical Visualization **Tarek Mahmoud Samy** *Renewable Energy Studies Sector ,Egyptian Electricity Transmission Company, Cairo, Egypt*

Abstract: This is a brief review paper on nonlinear capacitors and how it may have a major difference in energy dissipation when Compared with linear capacitors. In this paper we will discuss the energy dissipation difference between nonlinear and linear capacitors and apply the Graphene capacitor C-V curve as an example and its expected power dissipation then we will discuss other nonlinear capacitors dissipation.

Session 6：Thermal Energy Systems

Venue: Room UA1120
Chair: TBA

Time: 13:15pm-14:55pm

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SE0046 Time: 13:15pm-13:35pm	An approach for energy conservation management systems in buildings **Nasser Ayoub**, Farayi Musharavati, Shaligram Pokharel and Hossam Gabbar *Helwan University, Cairo, Egypt*

Abstract: Making decisions about energy conservation options in buildings can be rather problematic as they involve several tradeoffs between project stakeholders. Furthermore, the level of details required in making a decision by building designer and project manager is different from that of building owners or investors. The former requires great details and technical knowledge that can be used to achieve desired energy conservation levels in the building. This is considered as Detailed Design Level, DDL. The later requires an abstract level of details for demonstrating the potential of different energy conservation scenarios to the clients or stakeholders in terms of cost and energy conservation levels. This is called the Client Demonstration Level, CDL. In this paper, we are proposing a two-level management system that can be used for supporting energy conservation decisions in buildings. The proposed system consists of four main parts; Energy Semantic Network, ESN, databases; a simulation and optimization module; risk- based LCA/ LCC Module; and a user interface. The ESN database includes relevant data about building database, energy supply systems database, demands, and control network database. The proposed, two levels, system is a pilot system to deal with the scope difference in the problem formulation. For example, a macro-level, such as that of CDL, should present various energy conservation scenarios, their economic possessions (the scenario application costs) and their potential environmental benefits in an abstract level of details. Based on decisions made at the CDL, the designers can determine detailed design specifications that meet these decisions, such as the optimal sizing of the HVAC system, rigorous models considering the energy demand and supply control, life cycle costing optimization and environmental feasibilities and risks. A simple description of the system is presented here.

SE0005 Time: 13:35pm-13:55pm	Improvement of the thermal performance of the v-corrugated plate solar air heater with PCM by using insulated upper cover during night **S. M. Shalaby**, A. E. Kabeel, A-Khalil, M. E. Zayed *Tanta University, Egypt*

Abstract: The dew phenomenon of ambient air is considered the major problem associated with solar air heater when thermal energy storage is used. The current research was mainly conducted for solving this problem. This was simply achieved by covering the upper side of the heater by insulated cover during the night period. For this purpose the v-corrugated solar air heater integrated with phase change material (PCM) as the most efficient heater as reported in the literature was constructed and tested with and without using insulated upper cover during night. When the insulated upper cover was used during night, a significant increment in glass cover temperature was found. In addition, the absorber plate and the PCM temperatures were slightly higher than their corresponding values obtained without using insulated upper cover. It is also found that the use of the insulated upper cover during night increases the outlet air temperature and daily average efficiency by 2-4 ^{o}C and 6.6%, respectively. It is also concluded that the heater operation time increases by 1.5 hrs when the insulated upper cover is used.

SE3002-A Time: 13:55pm-14:15pm	Machine Learning in Demand Forecasting and Energy Management in Smart Water Grids **Mo'tamad H. Bata**, Rupp Carriveau, David S.-K. Ting *University of Windsor, Canada*

Abstract: The efficacy of machine learning techniques and the effect of an accurate short-term water demand forecasting models on grid reliability and energy management are portrayed herein. One of the most ubiquitous techniques in demand forecasting is Artificial Neural Networks (ANN). Sixteen Nonlinear Autoregressive (NAR) ANN models were developed, trained, tested, validated, and deployed to forecast 24 hours ahead and 1 week ahead. The models differ in three aspects, the input data, the data time span, and the data continuity. The results show that the models with exogenous data inputs, NARX, outperformed the models with single historical data input (i.e. NAR). Moreover, the models with only one year data divided tri-annually have shown better performance compared to those used continuous five years or one year data. The application of these models in energy management plans for interconnected water utilities is also demonstrated.

SE0105 Time: 14:15pm-14:35pm	Thermal Energy Storage for Homes **Balaji Venkatesh** *Markville Secondary School, Canada*

Abstract: Conventional energy management solutions for homes that use sun energy typically convert energy from the sun, using photovoltaic (PV) panels, and then stores the energy into batteries.

However, the use of batteries is not environmentally friendly and is expensive. They become a limitation in the effective use of sun energy. This paper proposes a solution based on thermal energy storage. Thermal Energy Storage for Homes (TESH) is a solution to the problem of mismatched timing of solar energy and home energy demand when using solar power. By using the air mass in the home to store thermal energy, through by altering its temperature, one can avoid the need for other forms of energy storage, such as batteries. Batteries add to costs and pose environmental hazards, while the use of air mass as a thermal energy storage medium is cost-free. This makes solar energy an even more environmentally friendly alternative energy source, while simultaneously reducing the cost of infrastructure. This will allow more people to purchase and utilize solar energy, while also having less of a negative impact on the environment. The proposed method was implemented as a prototype and tested. Test results are reported and discussed.

SE0033 Time: 14:35pm-14:55pm	Solar Irradiance Prediction from Historical Trends using Deep Neural Networks Arghya Mukherjee, Antara Ain, **Pallab Dasgupta** *Indian Institute of Technology Kharagpur, India*

Abstract: Accurate prediction of solar irradiance is difficult because of the uncertainties in weather parameters. In this paper we present a forecasting model for solar irradiance based on historical data analysis and meteorological features, with the help of deep neural networks. A unique feature of the method is the use of historical trends of solar irradiance, which significantly improves the accuracy of our prediction model. We have validated the performance of our model using the data obtained from National Solar Radiation Database (NSRDB). As an application, the forecasted irradiance values are used to predict the power output of a photovoltaic (PV) plant set up in Kharagpur, India, within a low margin of error.

Session 7：Energy Storage

Venue: Room UA1220
Chair: Mohammed Safiuddin
University at Buffalo, USA
Time: 16:25pm-18:45pm

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SE3005 Time: 16:25pm-16:45pm	Design of Resilient Energy Storage Platform for Power Grid Substation **Ahmed M. Othman**, Hossam A. Gabbar *Faculty of Energy Systems and Nuclear Science, UOIT, Oshawa, Canada*

Abstract: This paper presents the design of a resilient energy storage platform to support the operation of power substation. The focus is to design a resilient energy storage platform, which includes battery and flywheel system, to be integrated with power substation to ensure stable and reliable power support to their customers. Power substation should meet the capacity market, which includes achieving the target demand response, voltage and frequency regulation requirements. The integration of energy storage system will provide balance between the loads and supply while stabilizing the performance of substation. This requires dynamic storage systems to charge quickly, and to stabilize the dynamic behavior of the substation during charging / discharging cycles. Resilient Energy Storage technologies can provide fast and dynamic response to enhance the integrated energy storage performance with substations. The paper will ensure better technical performance using clean energy technologies to support the structure and operation of the energy infrastructures. The proposed system will be applied on a real-world power grid substation in Ontario and the simulations and results show the effectiveness of the proposed technique.

SE0027 Time: 16:45pm-17:05pm	Firewall for Attribute-based Access Control in Smart Grids Christoph Ruland, **Jochen Sassmannshausen** *University of Siegen, Germany*

Abstract: This paper sets the focus on Attribute-based Access Control (ABAC) in Smart Grid environments such as substation automation scenarios. IEC 62351-8 describes Role-based Access Control (RBAC) and gives general guidance, but does not specify details. The development is often application specific, and typical challenges are legacy devices that cannot be updated to support

additional features such as certain security services. This contribution describes the development of a firewall that implements Attribute-based Access Control based on XACML to protect end systems from unauthorized access and commands It includes the description and implementation of common attribute-based access control policies and the description a system to distribute attributes. Finally, the paper demonstrates performance evaluation results for selected architectures and scenarios.

SE0047 Time: 17:05pm-17:25pm	ANN model for energy demand and supply forecasting in a hybrid energy supply system **Nasser Ayoub**, Farayi Musharavati, Shaligram Pokharel and Hossam Gabbar *Helwan University, Cairo, Egypt*

Abstract: This paper presents short term demand and supply forecasting model for a microgrid supply system used to secure the electricity demands of a commercial building, using one year demand data collected in hourly base. One-year renewable-based Micro-grid electricity supply data were produced by simulating its sub-systems (wind and PV supply systems). The Artificial Neural Network, ANN, forecasting models are built on predicting generation capacity and load demands in the next 24 hours. The ANN model presented here is a micro-level supply and demand forecasting model that links the decision making with the performance measures. To sustain the model results, the daily weather forecasts supplied by local authorities, are incorporated in our model. The models validity were tested by calculating the Mean Absolute Percent Error for the forecasted data. The ANN models' applicability and performance were tested in a case study for forecasting the demands of a hotel building and the supply potential of its microgrid supply sub-system. The building demands are assumed to be supplied by a hybrid supply system of 20% renewable-based Micro grid (10% Wind and 10% Photovoltaic) and 80% from electricity grid.

SE0069 Time: 17:25pm-17:45pm	Hybrid Planning Tool for Solar and Battery Systems in Ontario **Christopher Rockx** and **Joseph Euzebe Tate** *University of Toronto, Canada*

Abstract: There is increasing momentum for behind-the-meter renewable generation and storage installations due to an increased focus on limiting the environmental impact of electricity generation. Local energy policy influences the sizing and financial viability of these systems while also serving to promote the smart uptake of these technologies on the electricity grid. This paper proposes a methodology for optimal infrastructure sizing of small-scale solar photovoltaic generation and battery energy storage technologies required to become grid neutral under a net metering energy contract. A robust linear programming model is proposed, and probabilistic robustness guarantees are provided by manipulating the magnitude and frequency of uncertainty realizations using a budget of uncertainty approach. A practical test case is performed in Toronto, Ontario, and the results reveal that a 99% robustness guarantee requires additional infrastructure capital costs of $6,700 (26%) over the purely deterministic scenario investment of $25,700. Furthermore, it is shown that the net metering policy does not provide sufficient financial inventive to Ontario homeowners, and project costs exceed benefits by between $4,400 and $9,200 depending on robustness. Finally, Ontario net metering policy in its current form does not incentivize energy storage, and instead relies on the electricity grid as a free

and lossless storage device—a practice which is likely unsustainable. Future work is available to enhance the existing methodology or leverage the proposed methodology for application to new fields of research.

SE0011-A Time: 17:45pm-18:05pm	The Smart System for On Field Meter Testing in PEA, Thailand **Chitchai Srithapon** *PEA, Thailand*

Abstract: According to the service standard policy of Energy Regulatory Commission (ERC), Thailand in 2016, made all of electricity utility have to verify and test accuracy of all installing kWh meters for residential customer type in every 3 years. Provincial Electricity Authority (PEA) who is the biggest power utility in Thailand has about 18 million meters of residential customer type, where it required many work task and high budgets to achieve this mission. Therefore, the PEA team had developed the on field meter accuracy testing system to be able perform operating faster and make a cost saving. The system was completed with the innovative meter tester and software applications on both internet web base and smart mobile.

The meter tester equipment was designed with internal current source in case of no load consuming testing, and Bluetooth communication module for sent test result to a smart phone. The software applications used for interface with customer database (PEA-SAP) and generated working order. Then the mobile application will import test result and meter location to data server via internet communication system. The diagram of smart system for on field meter testing in PEA is shown in Fig. 1.

The implementation of this smart system for on field meter testing in PEA network has been shown operating efficiency improve by increasing meter tested capacity per day about 67% from comparing with the conventional process (30 meters tested/day). That means, it can be reduced the operation days to hit the target, while the data from this smart system also provide the benefit for distribution network operation improvement such as service voltage quality monitoring and meter location correcting in Geography Information System (GIS).

SE0076 Time: 18:05pm-18:25pm	Dust event impact on photovoltaic systems - Role of humidity in soiling and self-cleaning Humaid Al Badi, John Boland, David Bruce, **Mohammed Albadi** *Sultan Qaboos University, Oman*

Abstract: In the last decade, millions of dollars have been being invested in solar energy plants in regions prone to dust storms. Dust has a direct effect on the efficiency of solar energy plants by soiling and scattering of solar radiation. Hence it becomes necessary to analyse the potential of dust effect on Photovoltaic (PV) system performance as more solar energy is fed into national electricity grids. Dust impact on PV systems depends on how far the site is from dust sources in addition to wind speed and humidity. These factors in turn determine the soiling and scattering effect. Case studies are presented here to clarify the potential of dust impact from the main active dust sources in Western Asia. The results revealed a wide range of variability where the power output changed from −37% compared

with the day before the impact of a 48 hour old dust cloud in one site, to +14.4% in another site. The case studies showed the importance of wind in cleaning the PV during dust events. It also shows the role of humidity in impeding self-cleaning. It turns out that a PV site influenced by dry desert air is more suitable for self-cleaning PV systems, compared with a site influenced by humid air. This outcome might help PV system investors to select a PV plant's location to be as far from the sea or extensive water sources as possible in regions prone to dust storms such as Western Asia.

SE0031-A Time: 18:25pm-18:45pm	The Power System Analysis Study and Mitigation Output Fluctuations of 4 MWp On-Grid Solar PV Power Plant Integration in Badak LNG Bontang due to Cloud Passing **David Hasurungan** *PT Badak NGL Bontang, Indonesia*

Abstract: Badak LNG is LNG plant located in Bontang Indonesia. To support the plant operational, Badak LNG are equipped with 19 Boilers, 9 x 12.5 MW Steam Turbine Generators, 1 x 12.5 MW Gas Turbine Power and 1 x 5 MW Diesel Emergency Power Generator. To reduce the fuel consumption from power generation, through 2017-2018, Badak LNG has implemented 1 MWp and planned to add 3 MWp Solar PV Power Plant into the existing electrical power system. Prior to implementation, two studies are done to ensure that the implementation will not disturb the existing operational: Power System Analysis and Steam Balance Analysis.

The grid stability studies have been done to evaluate the impact of solar PV implementation into the existing Badak LNGs power system. The studies have shown that for all worst possible scenarios, the additional solar PV power plant will not disturb the stability of existing grid. On the other hand, the simple steam balance study is also done to check whether the steam generation is sufficient to drive the operational process. The study has shown that the power reduction due to solar PV integration will not disturb the existing operational system.

However, the variability of solar irradiance with a high ramp-rate, caused by cloud passing, can create fluctuation in the PV output. This fluctuation potentially disturbs the steam balance and also the voltage level in the system. In order to stabilize the plant operational, the energy storage solution is proposed and evaluated.

Session 8：Transportation Electrification

Venue: Room UA1120
Chair: Elna Holmberg
Chalmers University of Technology
Time: 16:25pm-18:45pm

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SE0101 Time: 16:25pm-16:45pm	Frequency Regulation Provision Using Cross-Brand Bidirectional V2G-Enabled Electric Vehicles **Seyedmostafa Hashemi**, Nataly Bañol Arias, Peter Bach Andersen, Bjoern Christensen, Chresten Træholt *Technical University of Denmark, Denmark*

Abstract: With the increasing number of electric vehicles (EVs) in use, concern about their impact on the power quality of local distribution grids is also increasing. However, efficient control of state-of-the-art EVs and their supply equipment has a great potential not only to minimize the grid impact from EV integration, but also to provide desired services for system operators in renewable-based energy systems. This paper presents and analyzes the results from the demonstration of frequency-controlled normal operation reserve (FCR-N) that is among the primary frequency regulation services in the Nord Pool energy market. EVs from different EV manufacturers as well as advanced bidirectional DC chargers are implemented in the demonstration, which is the first vehicle-to-grid (V2G) demonstration in the Nordic area with commercially available components and cross-brand EVs. A centralized control method is implemented, and two-way communications links are established to send the control signals and receive the measured data on a second-by-second basis. The results associated with the operation of EVs with different battery capacities providing FCR-N are presented, and several parameters required for validating the quality of support for FCR-N are discussed based on the demonstration outcomes. The results confirm that V2G-enabled EVs are able to provide high quality and very fast responses, and pave the way for future renewable-based energy systems.

SE0106 Time: 16:45pm-17:05pm	An Assessment of Batteries form Battery Electric Vehicle Perspectives **Devang Bhatt** and Mohamed El. Darieby *University of Regina, Canada*

Abstract: A battery is the key component in Battery Electric Vehicles. Main challenge for the Battery Electric Vehicle is low range and need frequent charging. Another issue is the longer charging time

required by the batteries. In this review paper different types of batteries and their development is discussed. Lithium Ion, Zebra and Lead acid battery are discussed from Battery Electric Vehicle point of view. Electric motors another key component in electric vehicles is discussed with application of batteries point. The technological development in the batteries to overcome barriers for the electrical vehicle can be a solution, but use of super capacitor or small internal combustion engines as range extender in conjunction with the batteries sounds to be an smart alternative for the market penetration of electric vehicles. This paper will provide current trends in this field.

SE0107 Time: 17:05pm-17:25pm	Incorporating Saturation in Permanent-Magnetic Synchronous Generator Modeling for All-Electric Ship Applications Aboelsood Zidan, **A. F. Okou**, Boubacar Housseini, M. Tarbouchi, D. Bouchard *Department of Electrical and Computer Engineering, Royal Military College of Canada, Kingston, ON, Canada*

Abstract: Increasing ship-board power demand coupled with environmental sustainability initiatives has created interest in pursuing all-electric ships (AES) for both commercial and military applications. AES can be equipped with power electronic components, loads, machines, and cables. Many electric generator topologies can be used for AES. To our best knowledge, permanent-magnetic synchronous generator (PMSG) is the most attractive solution because it is characterized by low maintenance levels, high compactness, and quiet operation. To evaluate, provide information, and guide technology selection, modeling and simulation of AES is required. This paper proposes an accurate PMSG model to analyze the dynamic characteristics of the generation system and to support system critical operations in the event of dynamic load change or component failure. Saturation in PMSG is modeled by means of analytical expressions, which can be easily embedded in equivalent-circuit models and which has some distinct advantages over look-up tables. The proposed model can be used in real-time control applications and in computer simulations. Four case studies are investigated through computer simulations with Simulink. From the simulations, it is found that the PMSG model has accurate performance as the variations of voltages and currents within acceptable ranges.

SE0039 Time: 17:25pm-17:45pm	Distributed Lifetime Optimization of Wireless Sensor Networks in Smart Grid **Farzad Tashtarian**, Ahmadreza Montazerolghaem, Mahmoud Abbasi *Islamic Azad University, Mashhad, Iran*

Abstract: Wireless sensor networks (WSNs) have the potential for realization economical automation systems in a smart grid where the different type of sensors mote can be used to monitor a wide range of the smart grid environment's parameters. Energy restriction of wireless sensor nodes and consequently lifetime of the network is a real challenge in WSNs applications like the smart grid. The WSN lifetime can be formulated as an optimization problem. In this paper, the alternating direction method of multipliers (ADMM) algorithm is used to implement a novel distributed iterative algorithm for the problem of extending the sensor network lifetime. The proposed algorithm has some striking feature that including use of local information, low overhead of message passing, low computational complexity, fast convergence, and reduced energy consumption. The experiment results related to the

convergence and number of iterations required to achieve the stopping criterion presented. As well as, the results of proposed algorithm compared with the subgradient methods. In comparison, the proposed ADMM-based algorithm outperforms the other methods.

SE0014	Cross-media mesh networks for smart home and smart grid application
Time:	**Friedrich Wiegel**, Gerald Oberschmidt, Veit Hagenmeyer
17:45pm-18:05pm	*Karlsruhe Institute of Technology, Germany*

Abstract: A smart power grid demands for efficient and practical solutions for reliable communication. This is achieved in view of demand side management by using narrowband powerline communication as an additional transmission medium for existing wireless sensor and actuator networks. In addition, cross-media mesh networks are proposed to leverage constructively the resulting diversity of the complementary transmission media to improve the reliability and transmission rate of the hybrid low power and lossy network. The implementation of a dual-media transceiver that enables the construction of cross-media mesh networks and powerline channel measurements together with network performance results are presented. Further steps for realization and analysis of hybrid mesh networks are discussed.

SE0083	New Semi-Supervised and Active Learning Combination Technique for Non-Intrusive Load Monitoring
Time:	Ahmed M. Fatouh, **Omar A. Nasr**, M. M. Eissa
18:05pm-18:25pm	*Cairo University, Egypt*

Abstract: Non-intrusive load monitoring (NILM) is a procedure that is used to disaggregate the contributions of different appliances in a building. Various traditional techniques use supervised and unsupervised learning for disaggregation. Very few papers utilize the semi-supervised or active approaches. The two approaches are used in case of training data scarcity. The semi-supervised approach is prone to errors as training dataset is small, while the active leaning approach relies completely on the user to get correct labels. A technique that leverages the semi-supervised and active learning together is applied. This can reduce the number of samples required to the users, also can increase the accuracy of the semi-supervised algorithm while more reliable samples can be added. Many cases are studied and the results showed the robustness and reliability of the new combination. The proposed combined technique showed that the number of queries can be reduced to fifth without losing more than 4% of the accuracy. Also, by combining the semi-supervised and active techniques, the accuracy increased by 6% compared to the stand alone semi-supervised approach.

SE0096	Distributed Control of Photovoltaic Units in unbalanced LV Distribution Networks to Prevent Overvoltages
Time:	**Sébastien Mathieu**
18:25pm-18:45pm	*University of Liege, Belgium*

Abstract: As more and more photovoltaic units are being installed, some LV networks have already attained their maximum hosting capacity, i.e. the maximum amount of distributed energy resources that they can accommodate during regular operations without suffering problems, such as overvoltages. As an alternative to network reinforcement, active network management (ANM) can, to a certain extent, increase their hosting capacity by controlling the power flows. In the framework of ANM, a distributed control scheme was previously presented. It makes use of a distress signal sent by each participating unit, when its terminal voltage is higher than 1.1 p.u. All units then proceed to absorb the maximum reactive power available. If the problem is not resolved, the units proceed to active power curtailment. This paper extends this control scheme to the case of unbalanced three-phase four-wire distribution networks with single- and/or three-phase inverters. The control scheme works by first partitioning the inverters into four groups, three for the single-phase inverters (one for each phase), and one for the three-phase converters. Each group then independently applies a distributed algorithm similar to the one previously presented. Their performance are then compared to those of two reference schemes, an on-off algorithm that models the default behaviour of PV inverters when there is an overvoltage, and the other one based on an unbalanced OPF. Its resulting total curtailed energy always lies between the two, with the on-off algorithm presenting the poorest performance, and the proposed algorithm losing its edge when the network is strongly unbalanced.

Session 9：Safety and Security of Smart Energy & Grids

Venue: Room UA1220
Chair: Hadis Karimipour
University of Guelph
Time: 13:00am-15:20am

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SE0025	Deep Neural Network based Energy Disaggregation
Time: 13:00pm -13:20pm	**Sirojan Tharmakulasingam**, B.T Phung, E. Ambikairajah *University of New South Wales, Sydney, Australia*

Abstract: In smart electricity grids, energy disaggregation significantly contributes to better demand side management, load forecasting and energy savings via estimating appliance level energy consumption from the aggregated smart meter data. This paper proposes a deep neural network based system by combining convolutional neural networks and variational auto-encoders for energy disaggregation. Domestic Appliance-Level Electricity dataset (UK-DALE) is used along with the standard error measures such as Mean Absolute Error (MAE) and Signal Aggregate Error (SAE) in order to evaluate the proposed system performance. Test results show that the proposed system improves the state-of-the-art performance by 44% and 19% based on SAE and MAE respectively.

SE0066	Ant Colony Cleaning Behavior Algorithm based Multicast for SDN in Smart Grid
Time: 13:20pm -13:40pm	**Shen Wang**, Peng Zhang, Jun Wu, Yutao Zhang *Shanghai Jiao Tong University, China*

Abstract: Efficient power peak reduction is a classic scheduling target to make smart grid more safe. To handle multiple energy consumers, energy management are usually built based on game theory. Despite their effectiveness, they do not consider consumer preferences, which are however important in developing salient scheduling frameworks. This work explores consumer preference based social networking in computing optimized schedules to facilitate the incorporation in energy management. We propose the consumer preference driven intelligent energy management technique for smart cities using game theoretic social tie. In our technique, social communities are constructed based on the preference of electricity usage. Community pricing strategy is adjusted during each time period through leveraging

cooperative game theory. The simulation results demonstrate the effectiveness and efficiency of the proposed intelligent energy management technique.

SE0094 Time: 13:40pm -14:00pm	Implementation of a Scalable and Robust Messaging Solution for Flexibility Trading **Ferdinand von Tüllenburg**, Jia Lei Du, Georg Panholzer, Rafael Vidal *Salzburg Research Forschungsgesellschaft mbH, Austria*

Abstract: As Smart Grids highly depend on the information exchange between its components, messaging usually plays an important role. The messaging solutions used in Smart Grids are demanded to be scalable and robust. Scalable due to the usually large spatial extends and many communicating components, Robust due to the criticality of reliable information transfer for Smart Grid operation.

In context of a flexibility coordination paradigm, where controllable and decentralized power sources and loads are utilized for stable grid operation, this article focuses on the development and implementation of a suitable message-oriented middleware solution. Though, particularly designed towards the system architecture and functional requirements or the flexibility coordination use case, the envisaged messaging solution aims at being applicable to a broad variety of Smart Grid applications. Apart from describing the components of the messaging system, also an application programming interface for the messaging solution is introduced. This interface is provided to component implementors with special attention to ease-of-use. Finally, we provide some performance considerations and evaluations on the developed system.

SE0095 Time: 14:00pm-14:20pm	Evaluation of interoperability in the context of advanced metering infrastructure Ioannis Poursanidis, **Nikoleta Andreadou**, Evangelos Kotsakis, Marcelo Masera *Joint Research Centre, European Commission, Italy*

Abstract: Smart grid interoperability is the driving force for integrating new components and technologies into the electricity grid of the future. Interoperability is an essential requirement for the smart grid allowing different subsystems and services to produce the expected results. Advanced metering infrastructure (AMI) plays an important role as it provides insights on load demand patterns. This paper proposes an *Absolute Scoring Scheme* for supporting interoperability testing activities. The Scoring Scheme aims at quantifying the capacity of components of interest, i.e. Data Concentrators (DCs) and Smart Meters (SMs) to interoperate. The larger the pool of devices tested, the more accurate and reliable the *scoring scheme* turns to be; creating a reliable big picture of the assessed market of components. A *Test Verdict Scheme* supporting interoperability testing activities is proposed too. This work has been developed at the Smart Grid Interoperability Laboratory (SGI Lab) of the Joint Research Centre of the European Commission.

SE0098 Time: 14:20pm-14:40pm	Modeling Information Security Threats for Smart Grid Applications by Using Software Engineering and Risk Management **Yu-Tso Chen** *National United University, Taiwan*

Abstract: This paper introduces a novel information security threat modeling (ISTM) method on the strength of software engineering and risk management, named ISERM. Compared to the existed ISTM approaches, the ISERM adds the concept of determining functional components, referring to threat types, leveraging risk breakdown structure, and prioritizing key threats to form a new ISTM process. In the proposed ISERM approach, the software engineering approaches including product flow diagram, use case diagram, and data flow diagram are used; besides, two proposed tables STRIDE+p and threat breakdown structure (TBS) are applied to help the ISTM process in a reliable manner. In order to demonstrate the operation process of the proposed ISERM, an application of smart grid (SG) is taken as an example. The proposed ISERM considers the functional components of system, adopts software engineering methods, as well as invokes the security threat types and risk assessment mechanism, so that indicates a considerable research direction of systematic threat modeling. Besides, the demonstrated practice also provides a valuable and practical reference for information security design on SG applications.

SE0089 Time: 14:40pm-15:00pm	Investigation into the Issues Associated with closing an automated Normally Open (N/O) point on Medium Voltage (MV) Networks where Fault Location, Isolation and Service Restoration (FLISR) tool is planned **Fundiswa Mthethwa** and John Van Coller *University of the Witswatersrand, South Africa*

Abstract: The design of Medium Voltage (MV) Overhead Lines (OHL) is often radial in nature which makes back-feeding difficult and these networks are often long which increases their exposure to faults. This has resulted in poor network reliability. Customers are mainly affected by faults on the MV network, to which particular attention has to be paid. Permanent faults (involving equipment damage) have negative impact on customers since they experience outages or interruptions while the equipment is repaired or replaced. The impact on customers increases when these outages are long. Customers continue to demand higher levels of uninterrupted supply from the distribution network; therefore it is necessary to implement self-healing Smart Grid technologies. One such technique is Fault Location, Isolation and Service Restoration (FLISR). The main drive towards implementing FLISR is to improve electricity utility's network performance, increase electricity sales, improve flexibility and reduce the impact on the economy of outages therefore improving the performance of the distribution system. This paper discusses various ways to implement FLISR and will also focus on a case study on real distribution networks and look at the issues associated with closing a remotely controlled or automatically operated Normally Open (N/O) point for back-feeding. This paper aims to show how automated service restoration can reduce switching and restoration time from hours to

minutes.

SE0090 Time: 15:00pm-15:20pm	Overview of Voltage Support Strategies in Grid-Connected VSCs under Unbalanced Grid Faults Considering LVRT and HVRT Requirements **Masoud M. Shabestary**, Shahed Mortazavian, Yasser A-R. I. Mohamed *University of Alberta, Canada*

Abstract: Increasing utilization of grid-connected voltage source converters (VSCs) necessitates their incorporation in supporting the power system and providing ancillary services such as voltage support under unbalanced grid conditions. This paper first overviews the existing strategies, presented in the recent literature, for supporting the voltage under unbalanced conditions by grid-connected VSCs. These strategies are categorized into five groups and discussed in this paper. Second, the compliance of these five voltage support categories with the well-known low-voltage ride-through (LVRT) and high-voltage ride-through (HVRT) requirements is examined. Comparative simulation results illustrate the pros and cons of each category in supporting the connection voltage under the LVRT and HVRT regulation schemes. Two main findings are obtained based on the evaluation of different strategies in this paper. First, although all studied strategies could provide the LVRT capability in grid-connected VSCs, most of them are incapable of proper regulation in terms of the HVRT requirement under unbalanced conditions. Second, the mixed-sequence voltage support strategy has found to be the most effective one in complying with the LVRT and HVRT requirements since it controls both positive and negative-sequence current injection based on the unbalanced voltage sag characteristics.

Session 10：Micro Energy Grids

Venue: Room UA1120
Chair: Ahmed Othman
UOIT
Time: 13:00am-15:20am

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SE0007 Time: 13:00pm-13:20pm	Design and Comparison of Scheduling Schemes for Grid-connected Hybrid PV-Hydrogen-Battery Microgrid **Zhirui Liang**, Zhengxiang Song, Jianhua Wang, Guogang Zhang and Xian Wang *Xi'an Jiaotong University, China*

Abstract: Hybrid PV-Hydrogen-Battery microgrid is a promising mode to solve the energy crisis. First, three scheduling schemes for this microgrid with different PV power utilizing strategies are designed and compared. Diverse energy resources are adopted during the four periods divided by Time-of-Use prices to save electricity bill, while the proportions of centralized and distributed PV system in three schemes are modified based on feed-in tariffs to boost revenue. Moreover, battery capacities for three schemes are optimized and the performance of each scheme with the change of feed-in tariffs is analyzed. Finally, developing trends of these schemes are noted to assist customers in selecting the most applicable one.

SE0022 Time: 13:20pm-13:40pm	Micro Phasor Measurement Unit Phasor estimation by off-nominal frequency **George Daoud**, Hany Selim and Mohamed Abdelraheem *Assiut University, Egypt*

Abstract: Due to the high sampling rate of the power signals by Micro Phasor Measurement Units (μPMUs) tight restrictions on computing time of different algorithms are imposed. Especially when dealing with Phasor estimation by off-nominal frequency. Sampling the power signal with a frequency which is a multiple of the instantaneous power frequency is used to fix this problem. To perform this, Gabor Transform is applied to get the update of the instantaneous frequency each cycle. In this paper we propose many time complexity enhancements to allow the Phasor estimation during the limited intersample interval, and we validate our techniques using computer simulation and real implementation on microcontroller. Using the Arm Cortex STM32F407 microcontroller with the floating point core at

the maximum clock speed of 168MHz, we managed to perform all needed algorithms in about 43% of the intersample interval, and leaving the rest for data storage, display of relevant information and communication with the Data Center.

SE0024-A Time: 13:40pm-14:00pm	An Online Smart MicroGrid Energy Monitoring and Management System **Ahmed Abouarkoub**, Zhen Gao, Mostafa Soliman, Sungbin Suh, and Vincent Perera *Mohawk College, Electrical and Computer Engineering Technology, Canada*

Abstract: MicroGrids Electrical energy demand has shown an increase in the recent years, Distributed Energy Generation and Load management systems are essential components in modern MicroGrids. An effective and continuous monitoring of the Grid represent a challenge, online evaluation are necessary to improve the generation and load distribution performance.

This paper presents an energy saving and management design strategy based on Fuzzy Logic Control in a residential-connected MicroGrid. A control strategy based on human reasoning aimed to reduce the Grid power fluctuation, improve battery lifecycle via charging control. In this system. PhotoVoltaic cells "PV", Inverter, and Max Power Point Tracing MPPT are used in addition to a Battery bank.

The proposed method efficiently regulates the power flow of the MicroGrid to improve the Load-management performance. Experimental studies were carried out to test and validate the proposed system using an online Fuzzy-Logic regulation with different Loads and Battery-charge conditions. Results have shown an effective reduction of the load fluctuations profile, which is also expected to improve the instantaneous grid power balance and demands response.

SE3001-A Time: 14:00pm-14:20pm	The Role of Smart Water in the Climate-Led Energy Evolution Network (CLEEN) 2040 Rupp Carriveau, Lindsay Miler *University of Windsor, Canada*

Abstract: Globally, and here in Canada, energy systems are entering a remarkable time of transition. How energy is produced, distributed, and procured is changing at an accelerating rate. Trends toward the decentralization of energy harvesting, delivery, and commerce have the potential to disrupt historic energy utility business models. The treatment, movement, and consumption of water are also being influenced by these trends. In some regions where water can be sourced locally, there are considerations for water-micro grids. Analogous to electricity, efficiencies are gained where process (and potentially) potable water can be distributed nearby to high concentrations of consumers. Innovative commerce structures are also evolving including Blockchain based, peer—to—peer water transactions. The presentation will examine the potential benefits of establishing community water grid topologies. The enabling conditions necessary to make it feasible will also be discussed. Potential concerns and challenges will also be highlighted. Finally, the inextricable links between water and energy evolution will be detailed in the context of the CLEEN2040 network.

SE0028 Time: 14:20pm-14:40pm	Communication System Design for an Advanced Metering Infrastructure **Ricardo Siqueira de Carvalho**, Pankaj K. Sen, Lucas Feksa Ramos and Luciane Neves Canha *Colorado School of Mines, USA*

Abstract: This paper demonstrates a case study on the design of an Information and Control Technology (ICT) network for an advanced metering infrastructure (AMI) on the IEEE 34 node radial distribution network. The AMI application is comprised of 330 smart meters deployed in the low voltage system of the feeder and 33 data concentrators in the medium voltage system. A power line carrier (PLC) communication design was developed and simulated in Network Simulator 3 (NS-3). The result was validated by comparing the communication network performance with the minimum requirements from the IEC Std. 61968. The average global end-to-end delay is 216 ms and the maximum delay is 459 ms. All the measurement delays and the availability are according to the IEC Std. 61968.

SE0104 Time: 14:40pm-15:00pm	Energy Management System for Optimal Operation of Microgrids Network **Tanveer Iqbal**, Zar Khitab *Army Public College of Management and Sciences, Pakistan*

Abstract: This paper presents an Energy Management System (EMS) using JuMP-Julia for Mathematical Programing (MILP) with Gurobi Solver for a network of microgrids. In the network, there are three units of microgrids. These units of Microgrids consist loads, electrical storage system and photovoltaic arrays. The EMS evaluates the optimization problem for three scenarios: grid-connected, grid-disconnected and stand-alone of each microgid by considering the forecasted photovoltaic generation, load demand and import/export energy cost of the main grid for 24 hours of a day with one hour time interval. In scenario.1 the objective of the EMS is to minimize the operational cost and to maximize the profit by injecting the power to main grid. In scenario.2 and scenario.3 the only objective is to minimize the maintenance cost of local generation and scheduling the load for 24 hours. The results of this EMS show the suitability and sustainability in all scenarios in respect of coherence and time solving.

SE0078 Time: 15:00pm-15:20pm	Appraisal of Constraints Impeding the Integration of Distributed Energy Resources Network **Emmanuel Kobina Payne**, Lu Shulin, Qian Wang, Licheng Wu *Jiangsu University, China*

Abstract: Non-linear power flow impediments and uncertain power generation with variations from renewable generation resources put artificial constraints on distributed energy resources (DERs) network, which subsequently affects power delivery at the demand side. Generation intermittency coupled with load variability subjects the entire DERs integrated power scenario into a complex

regime. This inevitably, requires system regulation intelligence to impact optimal scheduling management for an assured power delivery, and to minimize network congestion. Available literatures have usually, lumped distributed renewable generation impediments saliently, to support objectives for developing frameworks for control strategies. The paper seeks to review the causes and characteristics of the constraints that threaten the integration of distributed renewable generation, and also the consequential effect these challenges pose to the network. It further proposes applicable reliability performance indices to support design analysis of DERs grid integration. The vulnerabilities are mostly developed through subsystems of the DERs system namely; generation source, network composition and demand side. The varying impact of the constraints affect the reliability of the system, hence the study.

Listeners

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Listener 2	**Nicole Bongangi Nsono** *Gouvernment of Congo, Democratic republic of Congo*
Listener 3	**Romain, Kanyinda Mukala** *Gouvernment of Congo, Democratic republic of Congo*
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Listener 7	**Imran Khan** *National Research Council of Canada*
Listener 8	**Shakeel Khan** *APEGA*

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Zhi Qu	SE0032	S1	28
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Zhirui Liang	SE0007	S10	62

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