PROGRAM

2020 8th International Conference on Smart Energy Grid Engineering

SEGE 2020

(Virtual Conference)

August 12-14, 2020

Oshawa, Canada

Organized by

Sponsored by

WELCOME MESSAGE

It is our great pleasure to welcome you to attend the 2020 8th International Conference on Smart Energy Grid Engineering (SEGE 2020). This year the event will run fully virtual our to COVID-19. This event will provide a unique opportunity for international scholars, researchers and practitioners who are working in the field of smart energy grid infrastructures, technologies, engineering design methods to get together and share their latest research findings and results.

We're confident that over the three days you'll get the theoretical grounding, practical knowledge, and personal contacts that will help you build long-term, profitable and sustainable communication among researchers and practitioners working in a wide variety of scientific areas with a common interest in energy generation, transmission and distribution infrastructures, energy storage, electrification, information and communications, and security.

On behalf of all the conference committees, we would like to thank all the authors for your contribution as well as the technical program committee members and external reviewers. Their high competence, enthusiasm, valuable time and expertise knowledge, enabled us to prepare the high-quality final program and helped to make the conference become a successful event.

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.

General Chair

Dr. Hossam A. Gabbar

July 31, 2020

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ONLINE PRESENTATION GUIDELINE

● Preparation

Equipment needed:

1. A computer with an internet connection (wired connection recommended)
2. USB plug-in headset with a microphone (recommended for optimal audio quality)
3. Webcam (optional): built-in or USB plug-in

Environment requirement

1. Quiet Location
2. Stable Internet Connection
3. Proper lighting

● How to use zoom

Step 1: Download Zoom from the link: https://zoom.us/download

Step 2: Sign up an account

Step 3: You can set up the languages and do some basic test

For more skills, you can find more video tutorials on:
https://support.zoom.us/hc/en-us/articles/206618765-Zoom-Video-Tutorials

Step 4: How to join the conference online

1) Open the program, search with your paper ID, find your presentation, you will see there is a meeting ID in each session.
2) Open the ZOOM, click the join, paste the meeting ID, then you can join the conference. (of course, you can not see anything right now, because the conference will open on August 12-14)

Step 5: Get familiar with the basic functions: Rename, chat, raise hands, and screen share, etc. The most important function is share screen, because you will use it for your online presentation on August 13 or August 14.

Step 6: On August 12, we will have test session, on that day, we will teach you how to use ZOOM and the functions mentioned above, so if you don't know how, no need to worry too much, but you must download ZOOM and sign it up, then you can join the conference.

● Join the text session before the formal session

To effectively control the time and avoid some unexpected situations, we advise you record your presentation ahead of time, play the video while it's your turn for presentation. The Video/presentation should be within 10 minutes, 5 minutes for Q&A, in total, one presentation is 15 minutes.

Attention please

1. Record
   The conference will be recorded, we will appreciate your proper behaviour.
2. Local Time Reminder
   The time shown in this schedule is Greenwich Mean Time (GMT-04:00) – Oshawa Time, you have to check on the program for your own test time and formal presentation time, and then exchange it to the local time in your country.
3. Video Instructions
   Authors can send your video or ppt (with the recorded voice explanation) to us by August 10 as a back-up, in case the internet connection failure or some unexpected situation.
   And you still can be online on August 13 or August 14. During your presentation, you can choose to play the video/ppt, or you also can do the live oral presentation online if there is no problem on your internet or software things.
   1). Author records a video introduction with their own image, speaking to the camera, introducing themselves: name, affiliation, brief description of scope of their work
   2). Author then switches to their slides and provides a voiceover describing images in each slide
   3). Authors need to be able to upload these presentations to a location specified by YOU in advance

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PROGRAM AT A GLANCE

[Greenwich Mean Time (GMT-4) – Oshawa Local Time]

August 12, 2020 (Wednesday)	07:00am-02:00pm	**Test Session (Session 1, 3, 5)**	Meeting ID: **650 5643 1912**
		Test Session (Keynote/Plenary Speakers, Session 2, 4)	Meeting ID: **946 9764 4935**
August 13, 2020 (Thursday)	08:20am-08:30am	**SEGE Opening, Welcome Message** Dr. Hossam A. Gabbar Ontario Tech University, Oshawa, Canada	Meeting ID: **650 5643 1912**
	08:30am-08:40am	**Opening Remarks** Dr. Les Jacobs VP Research and Innovation, Ontario Tech University, Oshawa, Canada	Meeting ID: **650 5643 1912**
	08:40am-09:25am	**Keynote Speech I:** Microgrids – Changing the Way of Thinking Energy Systems Dr. Josep M. Guerrero Center for Research on Microgrids (CROM), Department of Energy Technology, Aalborg University, Denmark	Meeting ID: **650 5643 1912**
	09:25am-10:10am	**Keynote Speech II:** Energy Conversion Systems for Transportation and Renewable Applications Dr. Yilmaz Sozer Electrical and Computer Engineering Department, University of Akron, USA	Meeting ID: **650 5643 1912**
	10:10am-10:30am	**Break Time**	
	10:30am-12:00am	**Session 1: Modern Electronic Technology and Application** **Chair:** Dr. Namdar Saniei	Meeting ID: **650 5643 1912**
		Session 2: Energy Development and Energy Management **Chair:** Dr. Yilmaz Sozer	Meeting ID: **946 9764 4935**
	12:00am-01:00pm	**Lunch Time**	
	01:00pm-02:15pm	**Session 3: Development and Implementation of Electrical Equipment** **Chair:** Dr. Mohsin Jamil	Meeting ID: **650 5643 1912**
		Session 4: Modern Power Grid System and Key Technologies **Chair:** Dr. Mohammed Safiuddin	Meeting ID: **946 9764 4935**
	02:15pm-02:30pm	**Break Time**	

	02:30pm-04:00pm	**Session 5: Smart Grid Operation and Management** **Chair:** Dr. Onur Elma	Meeting ID: **650 5643 1912**
August 14, 2020 (Friday)	08:20am-09:00am	**Keynote Speech III:** Repetitive Control for Power Electronic Converters used in Smart Grids Dr. Mohsin Jamil Department of Electrical and Computer Engineering, Memorial University of Newfoundland, Canada	Meeting ID: **650 5643 1912**
	09:00am-09:40am	**Plenary Speech I:** AI-enabled Energy Trading for Microgrids and Transactive Energy Systems Dr. Melike Erol-Kantarci School of Electrical Engineering and Computer Science, University of Ottawa, Canada	Meeting ID: **650 5643 1912**
	09:40am-10:00am	**Break Time**	
	10:00am-12:00am	**Special Session: SPANS (Symposium on Plasma And Nuclear Systems)**	Meeting ID: **650 5643 1912**
	12:00am-12:10pm	**SEGE Closing Ceremony** Dr. Hossam A. Gabbar Ontario Tech University, Oshawa, Canada	Meeting ID: **650 5643 1912**

Note: During the test session, participants are supposed to run the test one at a time. So you may need to wait for 3 to 5 minutes if someone else is in front of you in the waiting line. Please be patient until the host let you in.

KEYNOTE SPEAKERS

Dr. Josep M. Guerrero

Center for Research on Microgrids (CROM), Department of Energy Technology, Aalborg University, Denmark

Biography: Josep M. Guerrero (S'01-M'04-SM'08-FM'15) received the B.S. degree in telecommunications engineering, the M.S. degree in electronics engineering, and the Ph.D. degree in power electronics from the Technical University of Catalonia, Barcelona, in 1997, 2000 and 2003, respectively. Since 2011, he has been a Full Professor with the Department of Energy Technology, Aalborg University, Denmark, where he is responsible for the Microgrid Research Program (www.microgrids.et.aau.dk). From 2014 he is chair Professor in Shandong University; from 2015 he is a distinguished guest Professor in Hunan University; and from 2016 he is a visiting professor fellow at Aston University, UK, and a guest Professor at the Nanjing University of Posts and Telecommunications. From 2019, he became a Villum Investigator by The Villum Fonden, which supports the Centre for Research on Microgrids (CROM) at Aalborg University, being Prof. Guerrero the founder and Director of the same centre.

His research interests is oriented to different microgrid aspects, including power electronics, distributed energy-storage systems, hierarchical and cooperative control, energy management systems, smart metering and the internet of things for AC/DC microgrid clusters and islanded minigrids. Specially focused on maritime microgrids for electrical ships, vessels, ferries and seaports. Prof. Guerrero is an Associate Editor for a number of IEEE TRANSACTIONS. He has published more than 500 journal papers in the fields of microgrids and renewable energy systems, which are cited more than 40,000 times. He received the best paper award of the IEEE Transactions on Energy Conversion for the period 2014-2015, and the best paper prize of IEEE-PES in 2015. As well, he received the best paper award of the Journal of Power Electronics in 2016. During six consecutive years, from 2014 to 2019, he was awarded by Clarivate Analytics (former Thomson Reuters) as Highly Cited Researcher. In 2015 he was elevated as IEEE Fellow for his contributions on "distributed power systems and microgrids."

[Time]: 08:40am-09:25am, August 13

Speech Title: "Microgrids – Changing the Way of Thinking Energy Systems"

Abstract: A microgrid can be defined as a part of the grid with elements like distributed energy sources, power electronics converters, energy storage devices and controllable local loads that can operate autonomously in islanded mode but also interacting with the main power network in a controlled, coordinated way. Following the introduction of distributed control of these elements, cooperative control and hierarchical control schemes for coordination of power electronics converters in order to control the power flow and to enhance the power quality will be elaborated. Different technologies are combined together, such us power converters, control, communications, optimization, and so on. This way, energy can be generated and stored near to the consumption points, improving stability and reducing losses produced by large power lines. In distributed energy systems like microgrids, multi-agent systems technologies will be presented, including distributed control.

Previous experiences in the Danish electrical system like the Cell Controller project used these technologies to balance dispersed energy generation and consumption. The focus of this presentation will be on the analysis, modelling and control design of power electronics-based microgrids, as well as power electronics control and communications. Further, the interconnection of microgrid clusters will be emphasized as an important step towards utilization of the smart grid concept. In this talk examples of research and projects in real sites including conventional islanded systems installed in islands and rural remote areas, low-voltage distribution systems and DC microgrids for residential applications and homes electrical vehicle charging stations, ships, vessels, and ferries, and seaports will be shown.

Dr. Yilmaz Sozer

Electrical and Computer Engineering Department, University of Akron, USA

Biography: Yilmaz Sozer is a Professor in the Department of Electrical and Computer Engineering at the University of Akron. He received his B.S. degree in electrical engineering from the Middle East Technical University Ankara, Turkey and his M.S. and Ph.D. degrees in electric power engineering from Rensselaer Polytechnic Institute Troy, NY. His masters and doctoral work focused on power electronics and the development of control algorithms for electric machines. Before joining the University of Akron, Dr. Sozer has worked at Advanced Energy Conversion Schenectady, NY. His research interests are in the areas of control and modeling of alternative energy systems, electric machine drives, transportation electrifications, high-power isolated DC/DC converter systems, static power conversion systems that interface energy storage and distributed generation sources with the electric utility. Dr. Sozer has served as an associate editor and paper review chair for the IEEE Transactions on Industry Applications, IEEE Transactions on

Power Electronics, IEEE Transactions on Transportation Electrification, and IEEE Journal of Emerging and Selected Topics for Power Electronics. He is the past chair for the IEEE IAS Renewable and Sustainable Energy Conversion Systems Committee, and technical program chair for IEEE ECCE 2019, and IEEE IEMDC 2019.

[Time]: 09:25am-10:10am, August 13

Speech Title: "Energy Conversion Systems for Transportation and Renewable Applications"

Abstract: Both public and private sector groups are calling for greater investment in more-electric transportation and renewable energy sources, with the growing concerns about energy security, environmental impact, and resource limitations. Key components in enabling greater adoption of these systems are high power density and energy-efficient power electronic units, electric machine drives, and distributed energy storage. This presentation provides an overview of some of the research areas that have been pursued with the emphasis on power electronics architectures for drives and the utility interface with wide bandgap power devices. Also, the presentation will provide examples of the integration of distributed energy storage, and electric vehicles into the utility grid and microgrids. Recent advancements in the state of the art will be presented along with practical implementations.

Dr. Mohsin Jamil

Department of Electrical and Computer Engineering, Memorial University of Newfoundland, Canada

Biography: Dr. Mohsin Jamil is currently an Assistant Professor in the Department of Electrical and Computer Engineering at Memorial University of Newfoundland, Canada since August 2019. Between 2016 and 2019, he was working in the Department of Electrical Engineering at Islamic University of Madinah, Saudi Arabia. Between 2012 and 2016, He was working at the Robotics Department of National University of Sciences and Technology (NUST), Islamabad, Pakistan.

He earned his Ph.D. degree in Electrical Engineering from the University of Southampton, U.K. in 2012 and M.Sc. degree in Electrical Engineering from the National University of Singapore in 2008 with major in Automation and Control Engineering. He has done

another M.Sc. degree in Electrical Engineering from the Dalarna University Sweden in 2006. He did Bachelor of Engineering in Industrial Electronics Engineering form NED University of Engineering and Technology, Karachi, Pakistan in 2004.

He is author and co-author of several IEEE publications in different journals and peer-reviewed conferences. He is recipient of different awards and funding grants. He is an Associate Editor of IEEE Access and Senior Member of IEEE.

[Time]: 08:20am-09:00am, August 14

Speech Title: "Repetitive Control for Power Electronic Converters used in Smart Grids"

Abstract: Power electronic converters used in smart grids are widely employed as the interface and power flow management of distributed generators (DGs) to the utility. They manage the energy exchanges with the utility and in general control the power flow between DGs and the utility. They are normally used to connect renewable energy sources such as solar, wind, or marine, to the utility to convert DC or variable frequency AC into 50/60 Hz fixed frequency AC to inject into the utility or to supply local loads. They are also used to interface high power density microturbines, flywheel energy storage systems, batteries, and fuel cells. These converters play a vital role in the control of power flow and improvement of power quality by providing a low total harmonic distortion (THD) output current as laid down by guidelines and national/international standards. There exist different types of power electronic converters for interfacing with the utility. The most common is the two-level bridge converter. However, the need to improve efficiency and to reduce the size and cost of both the converter and the output filter has encouraged more research into using different topologies.

In this technical talk, we will discuss the role of power electronic converters, some common topologies and repetitive controller for interfacing renewable energy sources to meet national/international standards. Classical (PID) controllers normally exhibit poor performance especially when the utility voltage harmonic distortion is high. This is due to the low gain, and poor disturbance rejection of the PID controller at the utility harmonic frequencies. Repetitive feedback controllers have the ability to track or reject periodic disturbances, such as utility harmonics, as they naturally have high gains at the utility voltage harmonic frequencies, assuming that these frequencies do not change.

PLENARY SPEAKER

Dr. Melike Erol-Kantarci

School of Electrical Engineering and Computer Science, University of Ottawa, Canada

Biography: Melike Erol-Kantarci is Tier 2 Canada Research Chair in AI-enabled Next-Generation Wireless Networks and associate professor at the School of Electrical Engineering and Computer Science at the University of Ottawa. She is the founding director of the Networked Systems and Communications Research (NETCORE) laboratory. She has over 130 peer-reviewed publications which have been cited over 5000 times and she has an h-index of 36. Recently, she was selected for the 2019 list of "N2Women: Stars in Computer Networking and Communications" along with 8 other distinguished scientists. She has received the IEEE Communication Society Best Tutorial Paper Award and the Best Editor Award of the IEEE Multimedia Communications Technical Committee in 2017. She is the co-editor of three books on smart grids and smart cities. She has delivered 40+ tutorials and invited talks around the globe. She has acted as the general chair or technical program chair for many international conferences and workshops. She is a senior member of the IEEE. Her main research interests are AI-enabled wireless networks, 5G and 6G wireless communications, smart grid, cyber-physical systems, electric vehicles, Internet of things and wireless sensor networks.

[Time]: 09:00am-09:40am, August 14

Speech Title: "AI-enabled Energy Trading for Microgrids and Transactive Energy Systems"

Abstract: Renewable energy resources are underutilized worldwide, regardless of geography or economy. This is partly due to the challenge of integrating a large number of small-scale, distributed renewable energy generators to the utility power grid; and partly due to the intermittency and cost of such resources. The current practice for installing small generators is to invest for capacity that only meets the average demand of the consumers with rigid contracts, simply because in general, there is no stake in surplus energy from prosumers. In this talk, we introduce novel AI-based tools that will allow a P2P energy trading platform consisting of microgrids to become a part of the future transactive energy systems. Energy trading among microgrid communities promises to make use of the renewable energy more efficiently and strengthen the resilience of the power grid during disasters and attacks. Despite the advantages of a P2P energy trading

platform, there are several challenges that need to be addressed. First, reliable and low-latency communication among the peers is necessary to allow real-time negotiation of trading decisions. Second, uncertainties that result from generation, demand or participant behavior need to be addressed. In this talk, we will introduce our recent results on low-latency communications in microgrids that use reinforcement learning. In addition, we will introduce our Bayesian learning based techniques that address uncertainty and improve the microgrid coalitions that are formed to trade energy.

CONTENTS OF SESSIONS

Note: Please find out which session your paper is included in and join in the meeting room at least 10 minutes before the session starts.

Session 1: Modern Electronic Technology and Application

Session 2: Energy Development and Energy Management

Session 3: Development and Implementation of Electrical Equipment

Session 4: Modern Power Grid System and Key Technologies

Session 5: Smart Grid Operation and Management

ORAL PRESENTATION ABSTRACTS

Note:
• [Greenwich Mean Time (GMT-4) – Oshawa Local Time]
• Test Presentation time: 07:00 a.m. – 02:00 p.m., August 12, 2020 (**Meeting ID: 650 5643 1912, 946 9764 4935**)
• Formal Presentation time: 10:30 a.m. – 04:15 p.m., August 13, 2020 (**Meeting ID: 650 5643 1912, 946 9764 4935**)
• Please join in the room 5-10 minutes earlier

SESSION 1

Modern Electronic Technology and Application

10:30am-12:00am

Meeting ID: 650 5643 1912

Chair: Dr. Namdar Saniei
Ontario Tech University, Oshawa, Canada

ES0019	10:30am-10:45am Communication Delay Compensation by Adaptive Parameter Estimation for Electric Vehicle Aggregators Joining Load Frequency Control **Sinan Cai, Ryuji Matsuhashi** *The University of Tokyo, Japan*

Abstract: The introduction of a large amount of renewable energy to the power system is causing system frequency stability issues due to the randomness of its generation. Electric vehicles (EVs) are regarded as one of the most prospective solutions for system frequency regulation. EVs, when aggregated, can join the ancillary market for frequency regulation as the demand-side response. However, the communication delay of the control signal could degrade the performance of EVs and reduce the payback. This paper proposed a novel control method to compensate for the delay of frequency control signals for EVs in a power system which applies Flat Frequency Control (FFC). The implementation cost of the proposed method is small, and the competitiveness of EVs in the frequency regulation market could be boosted with the proposed method.

ER0018	10:45am-11:00am Frequency Excursion Mitigation in a Multi-Source Islanded Energy System using Meta-Heuristic Optimization Strategies Rohit Venkatesh, Pavitra Sharma, **Houria Siguerdidjane**, Dhananjay Kumar, H. D. Mathur *Universit´e Paris-Saclay CNRS, France*

Abstract: Distributed Energy Resources and Electric vehicles are getting more popular in the energy market. They are emerging as promising concepts that can bring a revolution in the field of energy resources and transportation systems. The integration of different renewable energy resources and electric vehicles leads to a comprehensive microgrid (MG). It is a fact that an increase in power demand leads to a drop in power frequency and vice-versa, which adversely affects the power quality of the system. Therefore, the primary idea of this research work is to regulate frequency by controlling the wind power and available EV power. In this paper, a detailed MG model is simulated in MATLAB/Simulink with wind and EV as one of the sources using fractional order PID (FOPID) controller. Further, parameters of FOPID controller is optimized by using Ant Colony Optimization(ACO) and Particle Swarm Optimization (PSO). The frequency responses, wind power, and EV power results are compared for three cases; FOPID without optimization, ACO based FOPID, and PSO based FOPID. The generalized wind model and total energy model (TEM) are used for simulating wind source and EV, respectively. Optimizer based FOPID controller provides a better response for the defined objective function.

ES0021	11:00am-11:15am Load Profile Modeling Using High-Frequency Appliance Measurements for Non-Intrusive Load Monitoring **Matthias Maier**, Matthias Bremer, Simon Schramm *Munich University of Applied Sciences (MUAS)/ Technical University of Munich (TUM), Germany*

Abstract: Many load disaggregation algorithms have been presented, capable of identifying individual appliances' operation within a buildings' electrical load profile. Publicly available datasets offer the potential to evaluate and compare these algorithms. Due to differing application areas, datasets show inconsistent characteristics, so exploitation of this potential is not straightforward. Aim of the presented work is to contribute towards solving this problem. We present a methodology for utilizing high-frequency appliance measurements for load profile modeling, while trying to keep modifications of the measured appliance features to a minimum. The voltage measurements were used to separate the appliances' events and states in current for each grid period, to be able to recombine appliance behavior in a user-defined manner. The modeled load profiles showed high accuracy compared to aggregated measurements.

The presented methodology can be applied to various datasets and appliance measurements, to create standardized load profiles for the development, evaluation and comparison of disaggregation algorithms.

ES0037	11:15am-11:30am A Mixed of Nonlinear Loads and their Effects on the Electrical Energy Billing **Roberto Perillo Barbosa da Silva**, Rodolfo Quadros, Hamid Reza Shaker, Luiz Carlos Pereira da Silva *University of Southern Denmark, Denmark*

Abstract: This paper investigates the electrical energy billing issues considering several nonlinear loads connected at the same time to the electrical system. Under nonsinusoidal conditions, the literature review shows that there is no consensus on what is the correct form of billing the consumers. The results show different effects, according to each billing framework and each mix of loads. In general, the power factor and displacement power factor improved. Therefore, the impacts on the electrical grids, from the power quality point of view, are reduced. Moreover, related to electrical energy billing, it is possible to conclude that the same consumer unit can pay or not for surplus reactive power, depend on the loads that are connected at the same time to the grid, as well as on the electrical characteristics of each load.

ER0045	11:30am-11:45am Simulation and Analytical Comparison Between Load Management Techniques **Amira M. Attia** *AIET, Egypt*

Abstract: Smart grid is the new road for improving and increasing assets electrical generation, transmission, and distribution. Among smart grid's advanced program is demand side management, which is the most effective system in increasing efficiency of the grid. In demand side management loads' consumptions can be controlled either directly or indirectly by utility. Direct control programs include load shaping techniques; load shifting, peak clipping, strategic load conservation, valley filling, and strategic load growth. While from indirect control is energy consumption schedule program. In this paper, it will be proven that load shifting is the best technique among direct control after categorizing direct control techniques into proper groups. So, the comparison between them will be valid. Then it is used in comparison with indirect control program to study which among them is more beneficial to customer and utility.

ES0052	11:45am-12:00am Implementation of K-nearest neighbor on Field Programmable Gate Arrays for Appliance Classification **Amleset Kelati**, Hossam Gaber, Juha Plosila, Hannu Tenhunen *Royal Institute of Technology (KTH), Sweden*

Abstract: Accurate appliance energy consumption information can perform with the Non-Intrusive Appliances Load Monitoring (NIALM) system. However, faster and advanced appliance classification accuracy enhanced by the implementation of the k-nearest neighbor (k-NN) classifier in hardware. A field-programmable gate array (FPGA) hardware implementation can speed up the processing timing with a high level of performance accuracy. The result proved that the HLS-based solution has reduced design complexity and time for cost-effectiveness. The Plug Load Appliance Identification Dataset (PLAID) is used as a benchmark for the implementation. The selected appliance identification is implemented using Xilinx Zynq-7000 and the HLS-based solution has used an area of 37.1% for LUT and 21% for FF from the available chip. Thus, the implementation improved the cost and classification accuracy with a processing time of 5.9 ms and the consumed power was 1.94 W.

SESSION 2

Energy Development and Energy Management

10:30am-12:00am

Meeting ID: 946 9764 4935

Chair: Dr. Yilmaz Sozer
University of Akron, USA

ES0032	10:30am-10:45am Simulation Platform for Optimal Pricing of a Distribution Utility with Distributed Energy Resources Operating in a Residential Community **Annie Atienza**, Blessie Nicole Delos Reyes, Michael Angelo Pedrasa *University of the Philippines Diliman, Philippines*

Abstract: The current power grid system in the Philippines allows the consumers to utilize any amount of electrical energy as long as they can pay for it. As a response, the utilities

need to meet the demand at all times by purchasing energy from the generating plants whatever the cost may be. Today, these distribution utilities started to explore the usage of distributed energy resources in order to cater these varying demands, especially the peak demand. Moreover, the number of consumers which implemented transactive energy schemes also continues to increase. If this interaction between the utility and the consumers will be well-coordinated, reduction in the electricity price and energy consumption would be possible. This paper describes a computing tool and was able to (1) solve for the electricity tariff, (2) produce schedule of energy dispatch from distributed generators and storage systems and (3) perform proper demand-side management through scheduling of appliance operations, in order to reduce the cost of customer energy consumption at the same time maximize the allowable utility profit.

ER0047	10:45am-11:00am A Clustering Algorithm for Connected Entities in a Transactive Energy System for Optimal Battery Usage **Jeet Dhoriyani**, Renison Macwan, C. D. Upadhyay *L. D. College of Engineering, India*

Abstract: Various new advances in the power systems technology have led to the grid modernization stage. The concept of microgrid has quickly developed in this modernized grid, aided by several key advances in renewable energy and battery energy storage systems. This has led to the rise of the Prosumer model of electricity usage, wherein a user does both: produce and consume energy. Guided by these factors the peer to peer energy transfer mechanism is slowly developing into a proper grid architecture. This paper aims to show the development of a clustering algorithm for connected entities in a system such that there is an optimal use of battery energy storage systems and renewable energy. For this purpose a system with several connected prosumer entities is chosen. The clustering algorithm is then deployed which clusters the entities in a manner that the subgroup is almost self-sufficient and also has an efficiently performing battery storage system.

ER0054	11:00am-11:15am An Optimal Electrical Energy Management Scheme for Future Smart Homes Sandali Walgama, Ushani Hasinthara, Anuri Herath, **Kalana Daranagama**, Sisil Kumarawadu *University of Moratuwa, Sri Lanka*

Abstract: The future trend in the energy sector is to have smart grid technologies that involve energy management schemes for domestic level consumers. This addresses the issue of increased energy consumption and the cost incurred in it. This project proposes

a solution to optimize the energy consumption and to reduce the energy cost, based on an optimal electrical energy management scheme designed for future smart homes using a Home Energy Management System (HEMS). Domestic devices can be either real-time or schedulable according to user's preference and they are connected to a smart meter through a HEMS. An energy constraint has been considered based on future peak demands and an algorithm that will optimize the energy management of the appliances has been developed. The proposed scheme is a novel algorithm based on the Dijkstra algorithm with lower complexity. The main objectives of this scheme are optimization of electrical energy usage, energy cost minimization and minimum interference to users' preferences. Simulation results are presented to allow comparison of the performance of different existing algorithms and proposed scheme.

ES0040	11:15am-11:30am Battery Energy Management of a Telecommunications Company to Participate in the Curtailment Market and Reduce the Total Energy Costn **Isa´ıas Faria Silva**, Mustapha Bouhtou, Matthieu Chardy, Cedric Bentz, Safia Kedad-Sidhoum *Orange Labs, France*

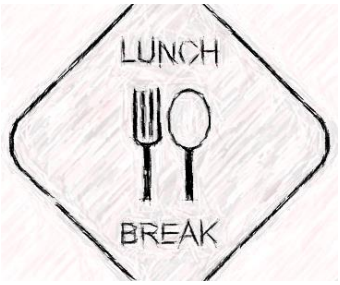
Abstract: The use of batteries as a backup in case of power outages is frequent in telecommunications companies that need to keep their services always active. Also, these batteries can be used when the energy costs more, to reduce the electricity bill, as long as the safety usage rules are respected. A new context of use is to participate in the curtailment market, which is a key financial lever for the transmission grid to balance energy demand and offer. The company would use its batteries if called upon to reduce its energy consumption when the power demand is greater than a country's production, receiving a reward in exchange. Our focus in this work is to optimize over time the use of batteries installed for backup in case of power outages to participate in the curtailment market and also to reduce the energy OPEX for the company. We formally state the related optimization problem and propose a mixed-integer program to address it. Such a model is investigated with tests based on real data of a telecommunications operator in France. Simulation results prove the efficiency of our solving approach and the relevance of using batteries to participate in the curtailment market and also to reduce the energy cost for the company.

ER0034	11:30am-11:45am Wind Power Forecasting Using Machine Learning: State of the Art, Trends and Challenges Kathrine Lau Jørgensen, **Hamid Reza Shaker** *University of Southern Denmark, Denmark*

Abstract: The future challenges in the power grid have become more real the last decade. The wind power production increases rapidly. Having compatible wind turbines in the electricity spot market, forces conventional powerplants to shut down. This affects the reserve markets whose cost increases as the wind power capacity grows. By having wind turbines participate in the reserve markets, the costs could be reduced. Wind turbines are now excluded from the Danish markets due to low reliability of forecasts. Wind power forecasts must reflect the reality if the TSOs are to rely on the availability of the wind turbines. A State-of-the-Art analysis of four machine learning methods, Neural Network, Support Vector Machine, k Nearest Neighbor and Random Forest, investigates the challenges and advantages of the algorithms within wind power forecasting. The State-of-the-Art results showed that Neural Network and Support Vector Machine are the most common algorithms within the field. By investigating the algorithms, it was found that Neural Network and Support Vector Machine have several parameters, which will increase errors, if tuned poorly. Further it was found that due to the many parameters, the algorithms can be modified to fit many specific cases. There is a growing trend in the general use of machine learning in order to digitalize wind power forecasts. A more stable, automatic, and human-error-free prediction of wind power will bring wind turbines one step closer in participating in the reserve markets.

ER0055	11:45am-12:00am Effects of Ultra-Fast Charging System for Battery Size of Public Electric Bus Onur Elma, **Md. Ibrahim Adham**, Hossam A. Gabbar *Ontario Tech University, Canada*

Abstract: Most of the DC fast chargers have 50-150 kW power rates in the market. These power rates may give a suitable charging time for personal EVs but not for commercial electric vehicles. Thus, the DC fast charger should be improved to charge bigger battery capacities in an acceptable charging time. Especially, the regular DC fast chargers cannot give acceptable charging time for the electric buses and/or electric heavy trucks. The new battery and power electronic technology make it possible to use much more power rate for fast charging. These high-power rate chargers are called ultra-fast charging and/or extremely fast charging. In this study, the ultra-fast charging system has been used to reduce the charging time of public buses. The updated charger standards such as CHAdeMO and SAE have been taken into consideration. Accordingly, the 450 kW ultra-fast charging system is used for on-route charging to analyze the battery size of the electric bus. In addition, the benefit of having an on-route charging station has been evaluated and compared with having no charging station in terminals. Public bus routes have been used to optimize bus battery capacity according to the bus schedule, stop time, and the ultra-fast charger power limit. The optimum battery size is calculated and optimum route length has been proposed for a given scenario for the E-buses.



12:00am-13:00pm

SESSION 3

Development and Implementation of Electrical Equipment

01:00pm-02:15pm

Meeting ID: 650 5643 1912

Chair: Dr. Mohsin Jamil
Memorial University of Newfoundland, Canada

ER0006	01:00pm-01:15pm A 5-TR Solar FPC-Cold Storage for Year-Round Waste Prevention of Food Products in Off-grid Areas **Meisam Sadi**, Ahmad Arabkoohsar *Aalborg University, Denmark*

Abstract: Food and fruit storage is one of the ways to deal with problems such as poverty and environmental degradation. This paper addresses this issue with the aid of renewable energy. To make the cold storage process an environmentally friendly one, it is proposed that solar thermal energy is implemented. In applications with the aid of solar energy, the production does not match the consumption variations, and hence, storing solar heat would be a solution. One way to store solar energy is through the use of storage tanks. The purpose of this paper is to provide cold storage for storing 12 tonnes of potato, by applying FPCs and storage tanks. There is a maximum cooling load of five-tone of refrigeration. A storage tank is required to supply the heat demand of the chiller. Different collector arrangement is considered to be investigated. The results show that for an increase of 12 hours of storage, the number of collectors increases by 10%. The lowest number of collectors was obtained for 24 hours of storage and a 6-series collector configuration. The highest number of collectors was achieved for 72 hours of storage,

with a 12-series collector configuration. The results also show that as the storage time increases, more collectors are required to support the absorption chiller.

ER0023	01:15pm-01:30pm Study on Novel Autotransformer Coupling Solid State Fault Current Limiter **Mo Yujie**, Lu Shuijin *Zhejiang University of Science and Technology, China*

Abstract: In this paper, a novel autotransformer (AT) coupling solid state fault current limiter (ATSSFCL), as a new FACTS device, is proposed. Compared with the conventional transformer coupling SSFCL, the AT coupling SSFCL has more compact structure, the volume and weight could be reduced considerably, the effect on the system can be negligible in the normal regime, especially during the load increasing time, the impact on the system could be suppressed considerably. In addition, the capacity of the bridge and DC reactor could be decreased greatly, so is the voltage level of the bridge. The topology of the AT coupling SSFCL is given, which is analyzed theoretically, and the performance of the ATSSFCL employed in system is simulated in the MATLAB/SIMULINK environment, which highlights the merits of the novel FCL.

ER0007	01:30pm-01:45pm ETC-Cold Room with Hot Storage Tank, a Reliable Solution for Prevention of Fruit Degradation **Ahmad Arabkoohsar**, Meisam Sadi *Aalborg University, Denmark*

Abstract: Every year in hot and arid areas of many developing countries, large amounts of fruits and vegetables spoil due to the lack of appropriate cooling systems. This problem is doubled in areas having low-quality power grids. To use the high-irradiation potential of hot areas, this paper investigates the solar cooling system integrated with the ETCs. This system is considered to provide a maximum of 5 tons of refrigeration for the annual storage of 12 tonnes of tomato. In this regard, solar-driven cooling becomes an effective method to attain sustainability goals including poverty, climate change, and environmental degradation. Due to the intermittency behavior of solar resources, the thermal storage unit is a solution to this defect. Here, an absorption chiller is going to be heated by a storage unit integrated with the evacuated tube collectors. The results show that the absorption chiller can be fully charged throughout the year, requiring a storage tank and a sufficient number of evacuated tube collectors. When six collectors are in the series arrangement and the case of 24 hours of storage, the least number of ETCs are required. The minimum number is 196.

ER0029	01:45pm-02:00pm Multi-Advisor Deep Reinforcement Learning for Thermostatically Controlled Heating in Smart Homes Andrew Tittaferrante, **Abdulsalam Yassine** *Lakehead University, Canada*

Abstract: This paper demonstrates the feasibility of applying Multi-Advisor Reinforcement Learning to the problem of adapting control to balance multiple objectives under user-defined importance weighting. Experiments are performed considering balancing temperature set-point tracking and the demand response objective of cost of energy consumption while objective importance is scaled according to user schedule. Experiments demonstrate the capability of this approach to balance different objectives according to user-defined objective importance vector.

ER0036	02:00pm-02:15pm A New Model Predictive Control Based Method for Control of Grid Connected Inverter Using Predictive Functional Control Hamid Mirshekali, Rahman Dashti, **Hamid Reza Shaker**, Reza Samsami *University of Southern Denmark, Denmark*

Abstract: Smart energy grid technology plays a crucial role in expediting transition towards cleaner and better distributed energy sources. Nowadays, renewable energy has gained a lot of attention in order to increase efficiency and to reduce the environmental impact of energy consumption. The output power of most used renewable energies such as photovoltaic is DC. Therefore, the inverter must be used to convert the DC voltage to AC to be able to be used in the grid. Consequently, the inverters are important components of smart grids. This paper presents a new model predictive control (MPC) based algorithm using a predictive functional control method to control the voltage and current of the grid-connected inverter. In this mode, the inverter dictates the frequency and voltage of the main grid and inject the required active and reactive power to the grid. The grid voltage is a disturbance to the state-space model of the inverter. To verify the performance of the proposed method several simulations are carried out. The results confirm that the proposed method performs well, and it is robust against different situations.

SESSION 4

Modern Power Grid System and Key Technologies

01:00pm-02:15pm

Meeting ID: 946 9764 4935

Chair: Dr. Mohammed Safiuddin
University at Buffalo, New York, USA

ER0010	01:00pm-01: 15pm Fault Location in Power Distribution Networks using Arbitrary Similarity Criteria in the Principal Component Subspace **Laiz Souto**, Joaquim Meléndez, Sergio Herraiz *Universitat de Girona, Spain*

Abstract: This paper presents a new strategy to support fault location in power distribution networks based on arbitrary similarity criteria in the principal component subspace. Input data consist of impedance measurements at the secondary transformer of one or more substation buses, which are used to build datadriven models of the grid operating conditions. The statistical models of actual operating conditions are further compared with a few reference scenarios to determine the network configuration and the type and location of the fault based on arbitrary features which minimize the variability of the data. Furthermore, this paper includes a case study with a real-based low voltage power distribution network to test the method under different faults.

ER0020	01:15pm-01:30pm Modeling and Control of Current-Source Converter-Based AC Microgrids **Amr Radwan**, Issam Khouri, Xichen Jiang *Western Washington University, USA*

Abstract: This paper addresses the integration of renewable energy sources (RESs) into ac microgrids using current source converters (CSCs). A proportional-and-integral (PI) current controller is designed and implemented in the inner-most loop to regulate the interfacing converters through a vector control strategy. A PI ac voltage controller is then tuned to regulate the common ac bus voltage. In the outer-most loop, a power sharing

scheme is implemented using active and reactive droop control to share the common ac loads. The design procedures for the system controllers is presented in detail. Unlike the commonly utilized voltage source converters (VSCs), it is shown that CSC-based ac microgrids have a superior performance against severe faults conditions. Time-domain simulations are developed within the Matlab/Simulink environment to show the effectiveness of CSCbased ac microgrids when compared to VSC-based microgrids.

ER0041	01:30pm-01:45pm Complexity Analysis of VMs Auction-Based Scheduling in Cloud Datacenters for Grid Balancing **Ahmed Abada**, Marc St-Hilaire *Carleton University, Canada*

Abstract: Auction-based mechanisms are widely used tools for price discovery and optimizing the allocation of resources under competition. However, the computational complexity of auctions is always a main factor to consider when determining the applicability of the different auction mechanisms for particular settings. In this work, we consider the complexity of our auctionbased scheduling system used for providing grid balancing by scheduling the consumption of excess energy on cloud datacenters. We implemented our system using the IBM ILOG CPLEX optimization solver and evaluated its solution-quality vs. timecomplexity under three different settings used to manage the solve-time required by the solver. Our results show that the solvetime of the proposed system increases quickly for larger problem sizes and therefore, the development of heuristic algorithms would be more practical for a wider range of scenarios.

ER0025	01:45pm-02:00pm Assessment of Dynamic Instabilities in Weak Grids with High Penetration of Power Electronic Loads Saeed Rezaee, Mehrdad Moallem, Jiacheng Wang, **Amr Radwan** *Western Washington University, USA*

Abstract: High penetration of remote active power electronic loads (PELs) with voltage-source converter (VSC) interface into weak grids (WGs) can induce instabilities. This is attributed to interactions between the VSCs and the high-impedance of the WG. In this work, small-signal analysis is conducted to derive the full-order linearized model of the VSC-WG interconnection. Further, participation factor analysis is utilized to identify the influence of control parameters on the system stability. Unlike previous works, two different pairs of eigenvalues are identified in the WG connection that are very sensitive to the changes in the VSC control parameters and can induce instability if the control

gains are more than certain values. Several time-domain simulations are conducted on a 5 MW VSC-WG system to verify the validity of the small-signal analysis. Furthermore, a comparison of the dynamic performance of WG system is presented for the case where the VSC is connected to a stiff grid (SG).

ER0049	02:00pm-02:15pm Approximate Power Loss Minimization in Radial Distribution Networks Using the Feeder Reconfiguration **Ahmed Gad**, Hossam A.Gabbar *Ain Shams University, Egypt*

Abstract: A fast and simple approach for reducing the total power loss in radial distribution networks has been proposed in this paper. It uses a flexible framework that could accommodate one or more selection features in searching for candidate configurations. Four features, as an example, are suggested here based on the authors' knowledge and experience, implemented on the 70-bus test system, and evaluated against the configuration with lowest power loss. Simulation results reveal that further investigations might be capable of bridging the local minima into which most solutions were trapped.

02:15pm-02:30pm

SESSION 5

Smart Grid Operation and Management

02:30pm-04:00pm

Meeting ID: 650 5643 1912

Chair: Dr. Onur Elma
Ontario Tech University, Oshawa, Canada

ER0017	02:30pm-02:45pm Cybersecurity Analysis for the Communication Protocol in Smart Grids **Zoya Pourmirza**, Aditya Srivastava *Newcastle University, UK*

Abstract: Smart Grids are smart electrical networks that use communication technologies to service the power grid. They are an interconnected, self-detecting-adjusting-correcting network of distributed loads and generators. The Substation Automation lies at the heart of Smart Grids, and IEC 61850 is an innovative communication and automation standard within Smart Grids substations. This study aims to explore a cybersecurity analysis of the communication protocols recommended under the IEC 61850 standard, namely GOOSE messaging protocol. GOOSE messaging has been chosen as the candidate protocol for testing due to its increasing prevalence in the standard and adoption by industry. Relevant attack vectors have then been investigated. Finally, this study demonstrated that GOOSE messages are vulnerable to a variety of attack vectors, such as Confidentiality, Integrity and Availability, which leave the systems prone to spurious operations or faulty tripping.

ER0030	02:45pm-03:00pm Image-based processing Mechanism for Peak Load Forecasting in Smart Grids Jiawei Dong, **Abdulsalam Yassine** *Lakehead University, Canada*

Abstract: The development of smart grid systems and the increasing number of smart homes that are equipped dispatchable loads have lead to the development of intelligent energy management mechanisms. Among these mechanisms is demand response, which allows utility companies to engage with smart homes in order to balance the energy

usage on a daily basis by dispatching available excess of energy into the grid. However, in order to determine the right time to dispatch/curtail energy from smart homes, efficient energy forecasting algorithms are needed to precisely determine the peak times. This paper proposes a novel forecasting system of daily electricity consumption prediction based on image processing of load curve structure. While there are several algorithms that deal with energy forecasting, one major challenge is that most of these algorithms are prone to high number of errors when predicting abnormal energy consumption days (e.g. shoulder season days, holidays, etc.). Our focus is on reducing the peak prediction error in the season changing period. In our system, we have one classification model based on the convolution image process and k-mean clustering to select better training sets and optimize the forecasting model. The description and results of our model are captured in this paper.

ES0046	03:00pm-03:15pm Decentralized Demand Response Power Management System for Smart Grids **Veniamin Boiarkin**, Waqar Asif, Muttukrishnan Rajarajan *University of London, UK*

Abstract: According to the rapidly growing demand for electricity, as well as the emergence of various types of participants inside a Smart Grid (SG), it is necessary to develop a universal approach to ensure the beneficial interaction of all participants within a SG, thereby reducing the demand for electricity from the Utility Grid (UG). First, we introduce a universal approach to designing SGs of various structures, thereby aiming at the total benefit for all participants. Secondly, an algorithm for implementing a profitable pricing policy within a SG is implemented, as well as penal mechanisms are implemented. Moreover, a decentralized scheme of interaction between participants within a SG using blockchain technology is implemented. Finally, the effectiveness of the approach is checked taking into account various indicators, including a different number of participants and a time interval.

ES0050	03:15pm-03:30pm Advanced Distribution Method for Smart Grids in the Mobility World Using Blockchain Technology **Surah Aldakhl**, Abraham Mezaael, Yamen Taleb, Dafer Alali, Mohamed Zohdy *Oakland University, USA*

Abstract: With the integration and arrival of mobility platforms and variety of vehicle types, the smart grid is being projected as a solution for the challenges regarding electricity

supply in the future. It is only evident and matter of future time when mobility platforms become an integral part to manage and distribute electricity. However, the complexity and security in the management and consumption of electricity data pose serious challenges in the adoption of the smart grid. To address these challenges, blockchain technology is being researched for applicability in smart grid with respect to mobility methods. Apart from its properties of distribution and high security layer, blockchain can be integrated within demanding mobility platforms to provide viable feedback and promote allocations of energy into proper storages. Energy distribution systems can also use blockchain to remotely control energy flow to a particular area by monitoring the mobility usage and feedback. One use case is when blockchain network manager to utilize mobility users to obtain energy status and deliver hash codes of designated and secured energy resources. Storing energy and matching platforms in the mobility world is a huge challenge to overcome. Finally, all related Smart Grid and mobility challenges for integrating blockchain are discussed.

ES0051	03:30pm-03:45pm Evolution of Machine Learning in Smart Grids **Tacio Souza Bomfim** *Salvador University, Brazil*

Abstract: The objective of this work is to investigate the evolution of the application of machine learning (ML) in the area of smart grids. It presents an overview of research that used ML in the area of smart grids, through the quantitative descriptive analysis of periodical articles and newspapers, registered in the IEEE Xplore Library database, in the period between the years 2010 and 2019. A total of 108 research publications were identified that address the application of machine learning in the area of smart grids. The study also present the incidence of each topic related to smart grids as well as the types of machine learning used in each document. As a result, it was concluded that the number of surveys has increased in the previous 3 years, meaning this is between 2017 and 2019, with the main research topics related to smart grids being safety and reliability of the electrical network and energy management / forecasting. Also, was indicated that the main-ly two techineques of machine learning that have been used in smart grid area was Neural networks and Support Vector Machine (SVM).

ER0053	03:45pm-04:00pm The Design of a Novel Smart Home Control System using Smart Grid based on Edge and Cloud Computing **Hisham Albataineh**, Mais Nijim, Divya Bollampall *Texas A&M University-Kingsville, USA*

Abstract: The Internet of Things (IoT) has transpired as a fascinating technology for smart cities, smart homes, and smart grids by using a vast amount of IoT data. A smart grid is one of the core components where transport, generation, delivery, and electricity consumption are enhanced in terms of protection and reliability. The existing power grid is suffering from many problems such as outages and unpredictable power disturbances, inflexible energy rates, unnoticeable customer fraud, and many other disadvantages. These problems lead to the ever-rising demand for fossil fuel and service costs. For example, the peak hour demand needs to be overestimated and more energy generated to minimize the risk of an outage. The main problem of the smart grid is the tremendous amount of data needs to be collected from the IoT devices, and processing the data is a challenge. Using and predicting a large amount of data in smart Grid and IoT is still in its infancy. To remedy this problem, we propose a hybrid solution by using the Cloud and Edge Computing to process the data. Processing and predicting at the edge that is close to the embedded devices and homes to save in latency and storage compared to putting all the processing in the Cloud. In this paper, we define a hybrid solution where we use the edge computing for the smart grid information processing where the microgrids are located on the edge of the IoT network, and on the Cloud to use for the power grid that distributes power to the microgrids. We proposed a machine learning engine that used the decision tree to establish the communication between the edge layer, failover between edges, and the Cloud layer.