Conference Program

SEGE 2021

2021 9th International Conference on Smart Energy Grid Engineering

2021 2nd International Conference on Clean and Green Energy Engineering

CGEE 2021

August 11-13, 2021 (Virtual Conference)

co-sponsored by

OntarioTech UNIVERSITY

IEEE TORONTO Section est. 1903 Advancing Technology for Humanity

SAISE

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Welcome Message

Prof. Hossam Gabbar

Ontario Tech University
Oshawa, Ontario,
Canada
Founder and General Chair of IEEE SEGE

It is our great pleasure to welcome you to attend the 2021 9th International Conference on Smart Energy Grid Engineering (SEGE 2021). This year the event will run in a fully virtual mode due to COVID-19. 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.

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.

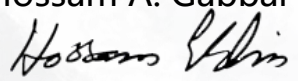
On behalf of all the conference committees, we would like to thank all the authors for your contribution as well as the technical program committee members and external reviewers. Their high competence, enthusiasm, valuable time and expertise knowledge, enabled us to prepare the high-quality final program 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, 2021

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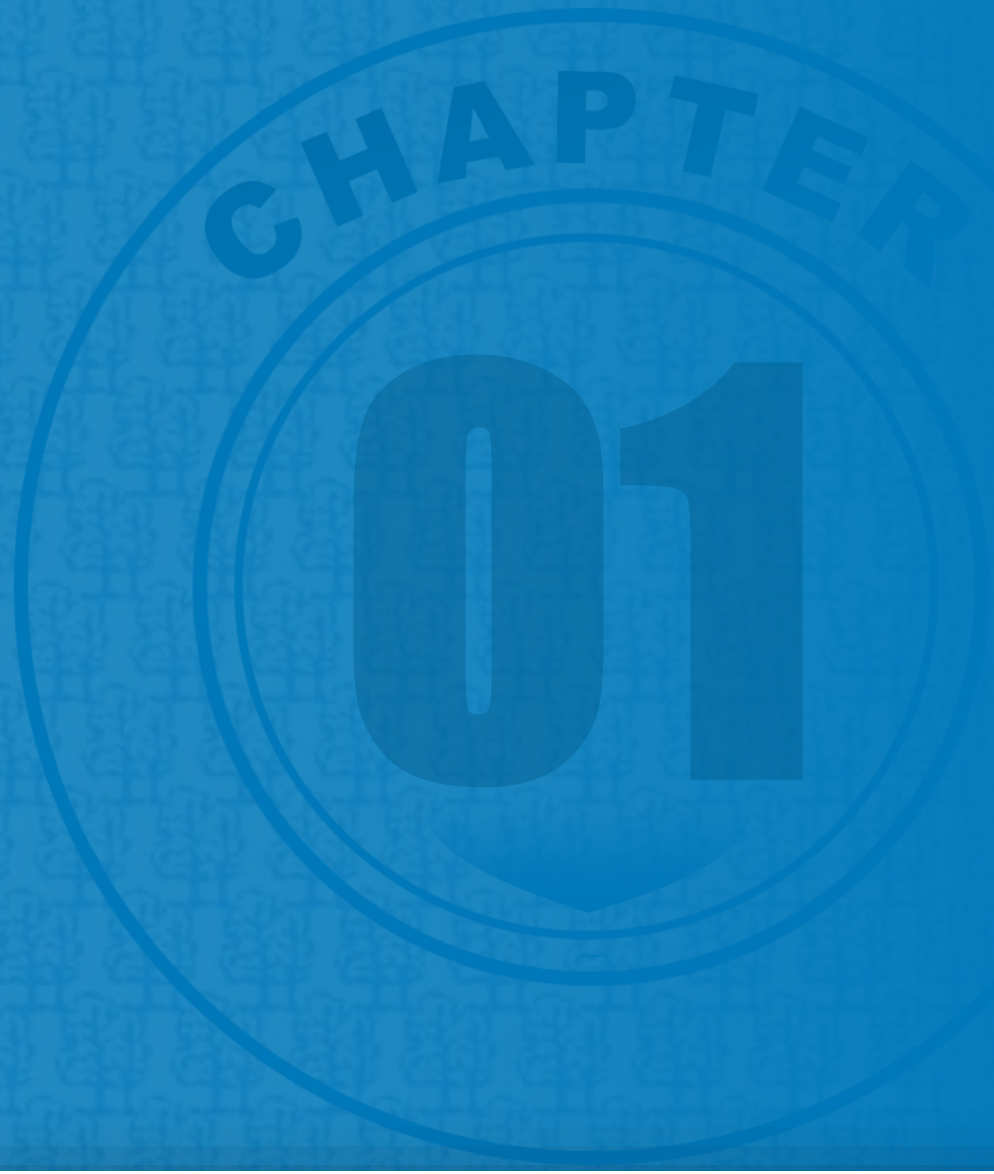
Online Presentation Guideline



- Preparation
- How to use zoom
- Tips

Online Presentation Guideline

Preparation

MEETING ID:

Room 1: **982 1787 4488** (Main room); Room 2: **940 1661 2175**

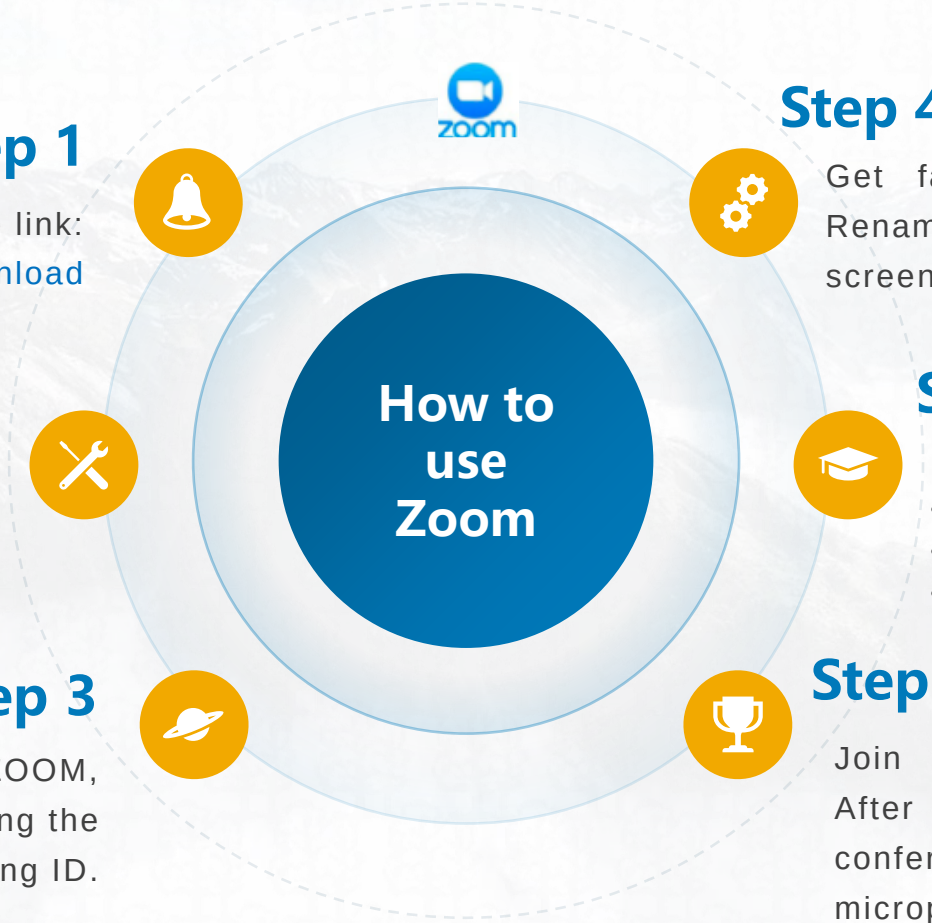
Equipment needed:

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

Online Presentation Guideline



Step 1

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

Step 2

Sign up for an account, Set up the languages and do some basic test.
Video tutorials: Click

Step 3

Open the ZOOM, join the meeting room by using the correct Zoom meeting ID.

Step 4

Get familiar with the basic functions: Rename, chat, raise hands, and share screen, etc.

Step 5

Rename as follows:

- Author: Paper ID-Full Name
- Conference Committee: Position-Full Name
- Listener: Listener-Full Name

Step 6

Join the test session on **August 11**. After you entered the conference room, the conference staff will assist you to test your microphone and share screen, etc.

Online Presentation Guideline

Tips

Record

The conference will be recorded, we will appreciate your proper behavior.

Local Time Reminder

The time shown in this schedule is Greenwich Mean Time (GMT-04:00) – Oshawa Time.

Enter in Advance

Please enter conference room 10 mins before the session begins.

Presentation/Video Instructions

The presentation/video should be within 10 minutes, 5 minutes for Q&A, in total, one presentation is 15 minutes.

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CONFERENCE COMMITTEES

- General Chair
- Technical Program Co-chairs
- Local Organization Co-chairs
- Technical Program Committee
- ...

Conference Committees

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Dr. Hamid Reza Shaker, University of Sourthern, Denmark
Dr. Mais Nijim, Texas A&M University-Kingsville, USA
Dr. Marc St-Hilaire, Carleton University, Canada
...

Women in Engineering Chair

Dr. Ruth Milman, Ontario Tech University, Canada

Treasurer

Dr. Manir U. Isham, Loyalist College, Canada

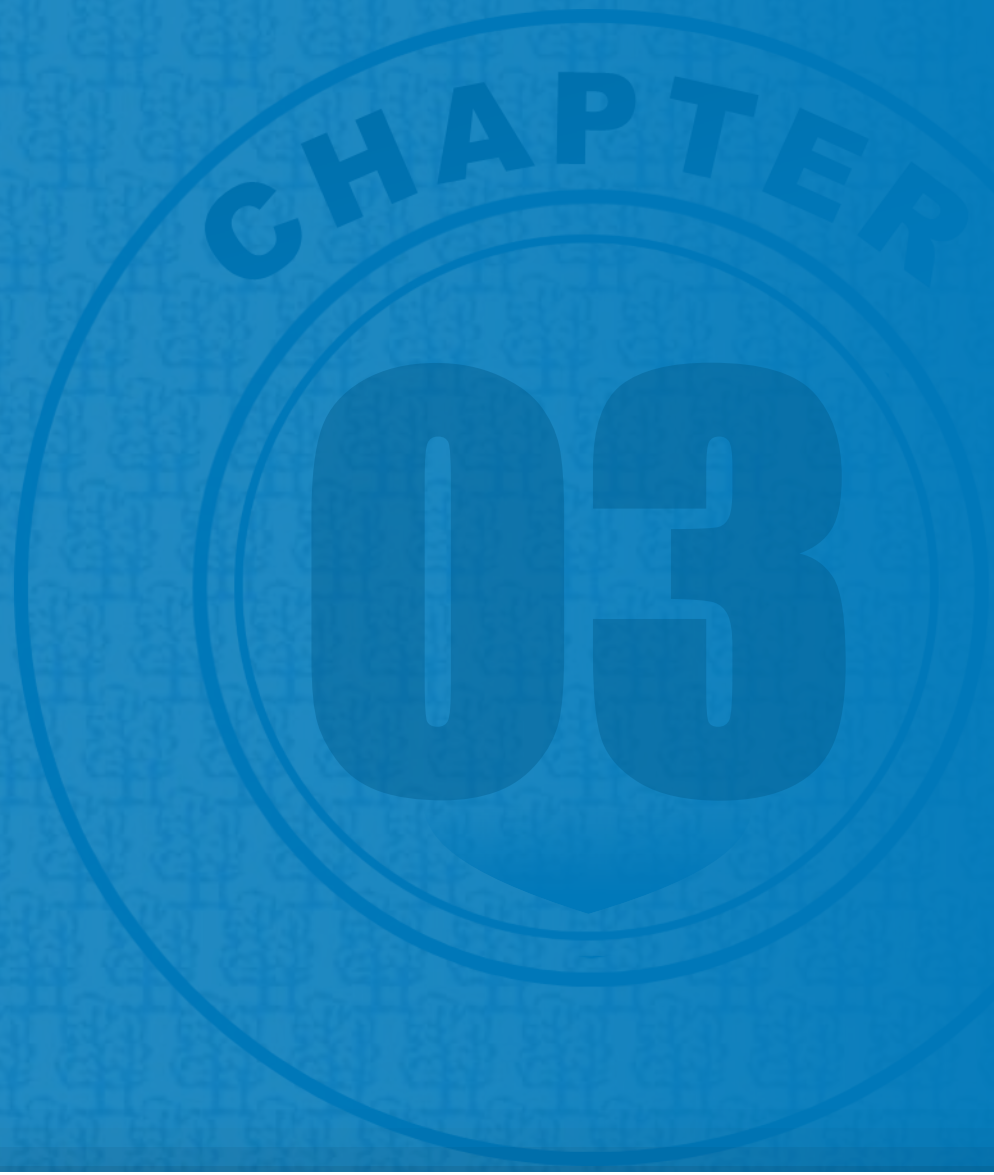
Award Chair

Dr. Filippo Genco, Ontario Tech University, Canada

03

Program at a Glance

- Test Session (Aug. 11, 08:30-15:30, GMT-4)
- Formal Session Day 1 (Aug. 12, 08:30-16:30, GMT-4)
- Formal Session Day 2 (Aug. 13, 08:30-12:30, GMT-4)



Test Session

SEGE 2021
CGEE 2021

August 11 (Wednesday), 08:30-15:30 [Greenwich Mean Time (GMT-4) – Oshawa Local Time]

Keynote and Plenary Speakers

Session 1, 3, 5

Paper ID: SG0023-A, SG0016, SG0014, SG0030, GEE002, SG3001, GEE017, GEE011, SG0006, GEE015, GEE007, GEE018-A, SG0043, SG0034, SG2001, SG0027, SG0040, SG0011, SG0009, SG0020

Session 2, 4, 6

Paper ID: GEE005, SG0013, SG0008, SG0017-A, SG0003, GEE016, SG0022, SG0041, GEE006, SG0019, SG0026, SG0039, SG0007-A, SG0012, SG0028, SG0021, SG0031, SG0010, GEE014, SG4001

Meeting ID	Meeting ID
982 1787 4488	940 1661 2175

Formal Session

SEGE 2021
CGEE 2021

August 12 & 13 (Thursday & Friday) [Greenwich Mean Time (GMT-4) – Oshawa Local Time]

Date	Time	Meeting ID: 982 1787 4488	Meeting ID: 940 1661 2175
Aug. 12	08:30-08:35	Opening Ceremony - Hossam A. Gabbar	
	08:35-08:40	Welcome Message from Guest of Honor	
	08:40-09:25	Keynote Speech I - Professor Alberto Borghetti	
	09:25-10:10	Keynote Speech II - Professor Saifur Rahman	
	10:10-10:30	Break Time	
	10:30-12:00	Session 1: New Battery and Energy Storage Technology	Session 2: Power and Energy Engineering
	12:00-13:00	Lunch Time	
	13:00-14:45	Session 3: Photovoltaic System and Renewable Energy	Session 4: Electrical Engineering and Automation
	14:45-15:00	Break Time	
	15:00-16:30	Panel Session: Transitioning of Hydrogen Energy Infrastructures and Community Applications	
Aug. 13	08:30-09:15	Keynote Speech III - Professor Luis (Nando) Ochoa	
	09:15-10:00	Plenary Speech - Professor Elisabetta Tedeschi	
	10:00-10:15	Break Time	
	10:15-12:00	Session 5: Microgrid and Smart Grid	Session 6: Electronics and Power System
	12:00-12:30	Closing Ceremony-Professor Hossam A. Gaber	

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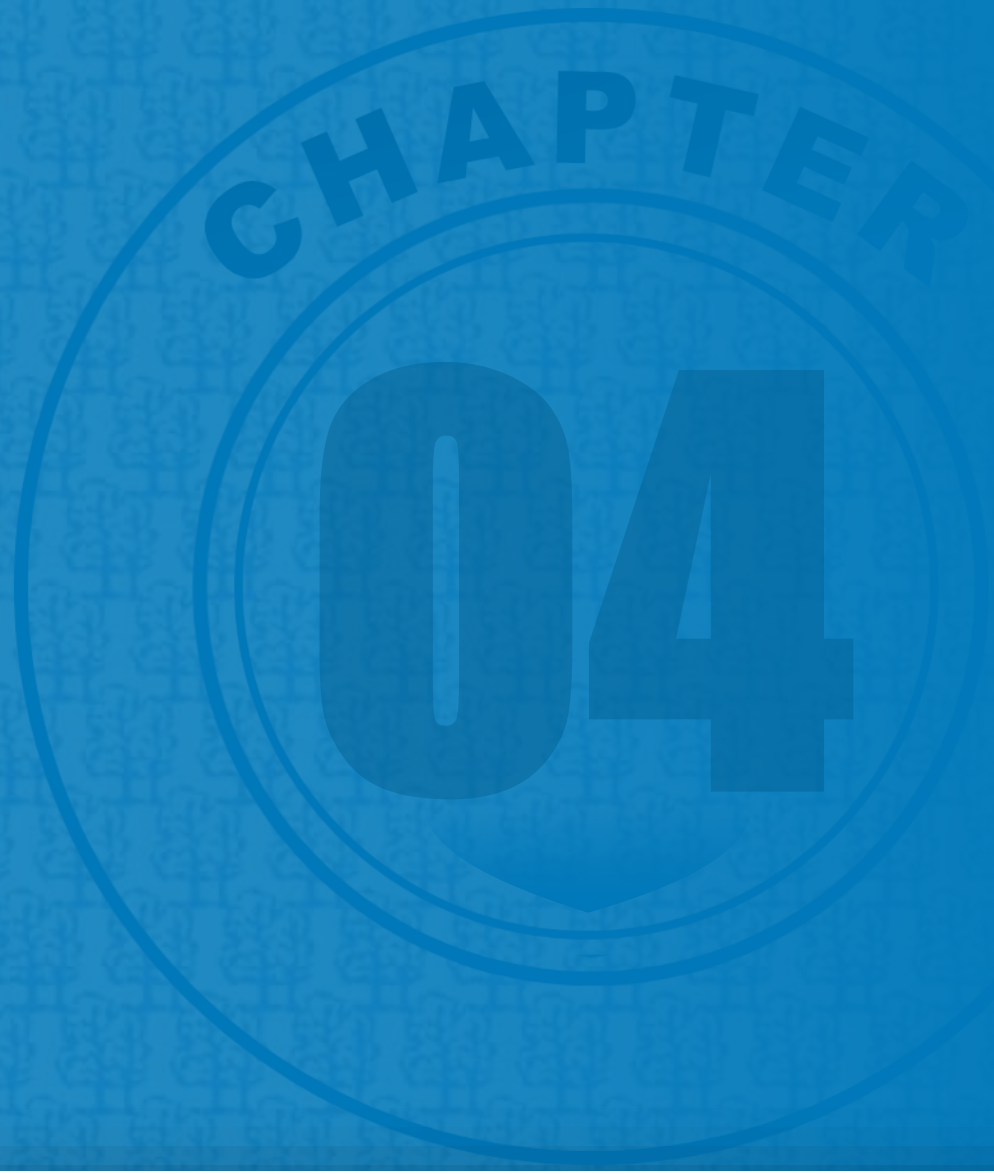
Keynote & Plenary Speakers

- Keynote Speaker
- Plenary Speaker



Keynote Speaker I

Prof. Alberto Borghetti

University of Bologna, Italy
IEEE Fellow

Alberto Borghetti (IEEE M'97-SM'03-F'15) is a Professor of Electrical Power Systems at University of Bologna, Italy. His research and teaching activities are in the areas of power system analysis, power system restoration after blackout, electromagnetic transients, optimal generation scheduling, and distribution system operation. He has authored more than 150 publications in various journals, monographs, proceedings of international conferences. He is co-author of 6 brochures of CIGRÉ (International Council on Large Electric Systems) and of the IEEE Standard 1410 - "IEEE Guide for improving the lightning performance of electric power overhead distribution lines". He is recipient of the ICLP Scientific Committee Award 2016 and the 2018 CIGRE Technical Council Award for Study Committee C4. From 2010 to 2017 he served as an editor of IEEE Transactions on Smart Grid. Since 2018 he serves as an editor of IEEE Transactions on Power Systems and as an associate editor of the Journal of Modern Power Systems and Clean Energy (MPCE). Since the beginning of 2019 he is serving as editor-in-chief of Electrical Engineering - Archiv für Elektrotechnik, published by Springer.

Keynote Speech I

- **Meeting ID: 982 1787 4488 Time: 08:40-09:25 (GMT-4), Aug. 12**

Renewable Energy Communities, with Day-Ahead and Intraday Scheduling

The talk focuses on the operation of renewable energy communities. The community is a set of prosumers (each of them may be equipped by local generation, energy storage systems and loads) with the possibility of direct transactions between them. The scheduling procedure must distinguish between the power exchanged with the external grid and the power exchanges between the prosumers in order to prioritize the use of local resources and self-consumption. The uncertainties on the forecasts of renewable production and load may be taken into account. The procedure should also provide the price of the internal transactions. This presentation is aimed to describe some models that could be useful for the operation of energy communities and distribution networks where direct trading between neighbors becomes significant. The performances of the approach are shown for various case studies and operating conditions.

Keynote Speaker II

Prof. Saifur Rahman

Director, Virginia Tech Advanced Research Institute, USA

President, IEEE Power & Energy Society, 2018 and 2019

Professor Saifur Rahman is the founding director of the Advanced Research Institute at Virginia Tech, USA where he is the Joseph R. Loring professor of electrical and computer engineering. He also directs the Center for Energy and the Global Environment. He is a Life Fellow of the IEEE and an IEEE Millennium Medal winner. He was the president of the IEEE Power and Energy Society (PES) for 2018 and 2019. He was the founding editor-in-chief of the IEEE Electrification Magazine and the IEEE Transactions on Sustainable Energy. He has published over 150 journal papers and has made over six hundred conference and invited presentations. In 2006 he served on the IEEE Board of Directors as the vice president for publications. He is a distinguished lecturer for the IEEE Power & Energy Society and has lectured on renewable energy, energy efficiency, smart grid, energy internet, blockchain, IoT sensor integration, etc. in over 30 countries. He has a PhD in electrical engineering from Virginia Tech.

Keynote Speech II

- **Meeting ID: 982 1787 4488 Time: 08:40-09:25 (GMT-4), Aug. 12**

Role of the Smart Grid in Facilitating the Integration of Renewables

With the focus on environmental sustainability and energy security, power system planners are looking at renewable energy as supplements and alternatives. But such generation sources have their own challenges - primarily intermittency. It is expected that the smart grid – due to its inherent communication, sensing and control capabilities – will have the ability to manage the load, storage and generation assets (including renewables) in the power grid to enable a large-scale integration of distributed generation. In a smart grid, information about the state of the grid and its components can be exchanged quickly over long distances and complex networks. It will therefore be possible to have the integration of sustainable energy sources, such as wind, solar, off-shore electricity, etc. for smoother system operation. But in order for this to be possible, the electric utility will have to evolve, and change their ways of operation to become an intelligent provider of these services. This lecture introduces the operational characteristics of renewable energy sources, and various aspects of the smart grid - technology, standards and regulations. It also addresses the interplay among distributed generation, storage and conventional generation to provide an efficient operational strategy in the context of the smart grid.

Keynote Speaker III

Prof. Luis (Nando) Ochoa

The University of Melbourne, Australia

Luis(Nando) Ochoa is Professor of Smart Grids and Power Systems at The University of Melbourne, Australia and part-time Professor of Smart Grids at The University of Manchester, UK. His expertise in network integration of distributed energy resources (DER) and his extensive portfolio of industrial and academic projects have led to 180+ publications, 70+ technical reports, and two patents, one filed by Psymetrix Ltd (now part of GE) and one filed by The University of Melbourne. Prof Ochoa is an IEEE PES Distinguished Lecturer and is also Editorial Board Member of the IEEE Power and Energy Magazine. Prof Ochoa is an IEEE Senior Member since 2012. He holds a Bachelor's degree in Mechanical and Electrical Engineering from UNI (Peru), and a Research MSc and a PhD in Electrical Power Engineering, both from UNESP Ilha Solteira (Brazil).

Keynote Speech III

- **Meeting ID: 982 1787 4488 Time: 08:30-09:15 (GMT-4), Aug. 13**

Making Electric Vehicles and the Grid Work Together

The increasing adoption of electric vehicles (EVs) will pose significant technical and economic challenges on the power grid, particularly on very infrastructure they are connected to: the electric distribution network. These networks have been traditionally designed to have no or limited controllability and, hence, are largely unmonitored. They will become the bottlenecks and therefore understanding how to best integrate EVs is critical to facilitate the electrification of our transport. This keynote will discuss the impacts of EVs and the challenges faced by distribution companies. Furthermore, it will present some of the findings of the large-scale UK trial “My Electric Avenue” in which more than 200 EVs were monitored for over a year to understand usage patterns as well as to test the effectiveness of EV charging point management to avoid network issues. The keynote will also provide an overview of the challenges brought by fast-charging stations and the need for future cities to have holistic planning approaches that involve traffic flows.

Plenary Speaker

Prof. Elisabetta Tedeschi

Norwegian University of Science and Technology (NTNU), Norway

University of Trento, Italy

Dr. Elisabetta Tedeschi joined the Norwegian University of Science and Technology (NTNU) as faculty member in 2013, and she is currently Professor within offshore grid at the Department of Electric Power Engineering. Since 2020, she is also Professor of power electronics and drives at the University of Trento, Italy. Having received a Marie Curie Fellowship, from 2011 to 2013 she was an Experienced Researcher at Tecnalia Research and Innovation in Spain. Subsequently she had a part time position as Research Scientist at SINTEF Energy Research, in Norway, between 2013 and 2014. In 2015, she was granted funding under the “Young Research Talent” scheme of the Research Council of Norway for an international project on Integrated Design and Control of Offshore HVDC networks. She has led and/or contributed to more than 15 national and international scientific projects. She is Technical Program Chair of the 13th Energy Conversion Congress and Exposition (ECCE) 2021, and has been program chair of the 17th IEEE Workshop on Control and Modeling for Power Electronics, (COMPEL) 2016, Member of the Technical Programme Committee of the IEEE CPE-POWERENG 2021, IEEE SPEC/COBEP 2019, IEEE COMPEL 2018, IEEE Smart 2015 and of the IEEE EVER-Monaco Conferences since 2012. Her research interests include design and control of energy conversion systems, offshore transmission and distribution networks and power quality issues.

- **Meeting ID: 982 1787 4488 Time: 09:15-10:00 (GMT-4), Aug. 13**

Offshore Energy Systems: Innovation and Challenges towards the Green Shift

With Europe setting the ambitious goal of carbon neutrality by 2050, and the entire world being engaged in a radical energy transition, there is an increasing urge to find innovative ways of generating, transmitting and saving energy, and no domains or applications can be left aside. Within this context, offshore energy systems can play a pivotal role in the green shift: ocean renewable sources have tremendous potential, and their exploitation is growing year by year. At the same time, the offshore environment hosts energy-intensive and technology-driven industrial applications that are being progressively electrified and digitalized to adhere to a smarter and greener energy paradigm. If offshore renewables, loads, and storage are systematically integrated and connected to the onshore power grid, they can become strategic assets to implement a trans-national “Super Grid”. This talk will present the opportunities, perspective and challenges offered by offshore energy systems. It will discuss how lessons learned from large interconnected power systems and/or microgrids may need to be adapted to cope with the demanding environmental and operational conditions of the offshore domain. It will further outline the key role of power electronics, advanced control, and new modeling/testing tools in supporting innovation in isolated and grid-connected offshore systems.

05

Oral Presentation Abstracts

- Session 1: New Battery and Energy Storage Technology
- Session 2: Power and Energy Engineering
- Session 3: Photovoltaic System and Renewable Energy
- Session 4: Electrical Engineering and Automation
- Session 5: Microgrid and Smart Grid
- Session 6: Electronics and Power System

August 12-Thursday (GMT-4)

Time	Meeting ID: 982 1787 4488	Meeting ID: 940 1661 2175
10:30-12:00	**Session 1: New Battery and Energy Storage Technology** Session Chair: Dr. Amr Radwan Western Washington University, United States	**Session 2: Power and Energy Engineering** Session Chair: Dr. Yasser Elsayed Ontario Tech University, Canada
12:00-13:00	Lunch Time	
13:00-14:45	**Session 3: Photovoltaic System and Renewable Energy** Session Chair: Assoc. Prof. Jennifer McKellar Ontario Tech University, Canada	**Session 4: Electrical Engineering and Automation** Session Chair: Assoc. Prof. Namdar Saniei Ontario Tech University, Canada
14:45-15:00	Break Time	

August 13-Friday (GMT-4)

Time	Meeting ID: 982 1787 4488	Meeting ID: 940 1661 2175
10:00-10:15	Break Time	
10:15-12:00	**Session 5: Microgrid and Smart Grid** Session Chair: Prof. Alberto Borghetti University of Bologna, Italy	**Session 6: Electronics and Power System** Session Chair: Assoc. Prof. Othman Nasri ENISO / University of Sousse, Tunisia

Session 1 New Battery and Energy Storage Technology

New Battery and Energy Storage Technology

Time: 10:30-12:00 August 12, 2021-Thursday (GMT-4)
Session Chair: Dr. Amr Radwan
Western Washington University, United States

Meeting ID

982 1787 4488

SG0023-A

10:30-10:45

Yirga Belay Muna,
Cheng-Chien Kuo

National Taiwan University of Science and Technology, Taiwan

Techno-Economic Optimization of Electric Vehicle Charging and PV/Wind/Battery Hybrid System with Different Battery Technologies in the Addis Ababa

Abstract—Universally, the increasing environmental impact of fossil fuel and depletion of its reserves are obliged a breakthrough change of the energy resources, infrastructures, vehicles, and tools that uses fossil fuels. Transportation is significantly needing the existence of conventional hydrocarbon fuels. Electric vehicles (EV) have the potential to reduce greenhouse gas emissions by reducing the utilization of oil in the transportation sector. Therefore, for the first time in the area, this study analyzes the technical and economic feasibility of EV charging and hybrid PV/Wind/Battery power system integration with different types of batteries for the residential areas located in Addis Ababa, Ethiopia. The optimal allocation, economic, emissions, electricity output, and sensitivity analyses of the relevant hybrid systems are all analyzed by using the new EV Charging Station Design Tool of HOMER Grid software, which offers two EV Charging Station models: On-Demand EV Charger and Deferrable EV Charger:
Results indicate that the optimal hybrid energy system is the PV/Wind/Battery system, which contains Solar PV, TeslaPP2 batteries, XL Gen TOU, and converter. This configuration corresponds to an initial capital of $7.39M, an operating cost of $946,274/yr, a total net present cost (NPC) of $ 19.6M, and a Levelized cost of energy (COE) of $0.117/kWh. Considering all energy sources Solar PV, Wind, Storage (EnerStore 50), XL Gen TOU is the optimal installation. The solar PV, TeslaPP2 batteries system provides the lowest NPC and COE compared to the only Utility system, while the PV/Wind/ Generic Lead Acid [ASM] Battery system has the highest NPC and COE owing to the high wind turbine costs. Furthermore, it is found that the PV/Wind/ EnerStore 50 is the most environment-friendly system compared to PV/Wind/ TeslaPP2 battery and PV/Wind/Generic Lead Acid [ASM] Battery systems. It is also found that selecting a suitable wind turbine can improve the comprehensive performance of the hybrid power system in terms of technology, economy, and environment.

Session 1 New Battery and Energy Storage Technology

SG0016

10:45-11:00

Quanjing Zhang, **Didi Liu**, Hongbin Chen, Junxiu Liu, Cong Hu

Guangxi Normal University, China

Dynamic Energy Scheduling Algorithm for an End-User with Energy Storage Device to Save Total Costs

Abstract—Energy storage can save end user costs in local energy markets that have time-varying pricing. However, energy storage device incur fixed acquisition costs which depend on their capacity. End user is faced with sophisticated energy scheduling tradeoffs in the local energy markets to account for these costs. In this paper, we consider a typical energy usage scenario where the end user draws energy from multiple types of energy supplies: the local power provider, the external power grid, and the user's own energy storage device. Our objective is to minimize the user's total costs (the total of purchased energy and storage) while meeting their energy demand in each time slot. Furthermore, the end user's energy demand, the local power supplier's prices, and the external power grid prices all vary over time. To deal with this variability, we formulated the energy scheduling problem as a stochastic optimization. We propose a dynamic algorithm based on Lyapunov optimization, and it is theoretically proved that the proposed algorithm can make the optimization target infinitely close to optimum. Finally, the effectiveness of the proposed algorithm is verified by simulation comparison. The algorithm provides a tool for end user energy scheduling where the user is equipped with energy storage device.

SG0014

11:00-11:15

Mostafa Rezaeimozafar, Rory Monaghan, Enda Barrett, Maeve Duffy

National University of Ireland Galway, Ireland

Optimal Scheduling for Behind-the-Meter Batteries under Different Tariff Structures

Abstract—The increasing deployment of photovoltaic systems and behind-the-meter batteries into power distribution systems has increased interest in optimal system operating conditions. Electricity tariff, as an indirect factor, plays a pivotal role in controlling the customers' behavior, especially in the presence of batteries. The residential sector, as one of the largest consumers, requires accurate analysis of the impacts of tariffs on its load profile for short-term and long-term planning. In this paper, a household equipped with a photovoltaic array and battery is modeled and the effects of flat-rate, stepped rate, time-of-use, and demand charge pricing structures on the battery charge/discharge model are analyzed. Furthermore, the effects of COVID-influenced consumption patterns and the increase in feed-in tariff for photovoltaic energy on battery scheduling are investigated. The battery scheduling problem is formulated as a non-linear optimization function, to minimize electricity costs for customers, and is solved using a Genetic algorithm.

Session 1 New Battery and Energy Storage Technology

SG0030

11:15-11:30

Zeenat Hameed, Seyedmostafa Hashemi, Hans Henrik Ipsen, Chresten Træholt

Technical University of Denmark, Denmark

Placement of Battery Energy Storage for Provision of Grid Services – A Bornholm Case Study

Abstract—Battery energy storage systems (BESSs) are gaining potential recognition in modern power systems. They enable higher renewable shares in power networks by overcoming issues introduced by the intermittent nature of renewable resources. BESSs also provide various grid services such as frequency regulation, voltage support, energy management, and black start. Choosing an appropriate BESS location plays a key role in maximizing benefits from its services. This paper aims at investigating BESS placement for providing grid services at the point of installation. The previous studies extended in this direction have not considered the requirements of a real project under which BESS is being deployed and have mainly proposed solutions for standard IEEE bus systems. Also, the focus has not been on providing ancillary services using BESS, but mainly on loss minimization. This paper, on the other hand, presents a case study on the BESS placement problem by investigating various potential locations in Bornholm Island for fulfilling the objectives of a BESS-related industrial project, namely BOSS. This is achieved by considering factors like stackability of BESS-services, integration of large-scale renewable resources, and viability of business models.

GEE002

11:30-11:45

Md Azmot Ullah Khan, Naheem Olakunle Adesina, Jian Xu

Louisiana State University, USA

Near Unity Absorbance and Photovoltaic Properties of TMDC/Gold Heterojunction for Solar Cell Application

Abstract—In this paper, near unity broadband absorption of Van der Waals semiconductors on a metallic substrate, and their photovoltaic performances in the visible spectrum are simulated. Ultrathin layered semiconductors such as Molybdenum disulfide (MoS2), Tungsten disulfide (WS2), Molybdenum diselenide (MoSe2), Tungsten diselenide (WSe2), Molybdenum ditelluride (MoTe2), and Tungsten ditelluride (WTe2) can create strong interference by damping optical mode in their multilayer form and increase light absorption at their heterojunctions with noble metals. From our simulation, it is observed that this absorbance can reach up to 94% when the semiconductors are placed on a gold substrate. The optimum thickness of these semiconductors in their heterostructures with gold is analyzed to create resonant absorption to generate the maximum amount of current density. The power conversion efficiency of the designed Schottky junction solar cells is calculated from their current density vs bias voltage characteristics that ranges from 1.57% to 6.80%. Moreover, the absorption coefficient, dark current characteristic, electric field intensity distribution in the device, and carrier generation rate during light illumination are presented with a view to characterizing and comparing among the parameters of TMDC based nanoscale solar cell.

Session 1 New Battery and Energy Storage Technology

SG3001

11:45-12:00

Omid Pourkhalili,
Rapinder Sawhney,
Sajjad Amrollahi Biyouki,
Hadi Parsian

University of Tennessee,
USA

Utility Scale Battery as Capacity Source for Electric Grid Systems

Abstract—United States Federal Energy Regulatory Commission passed order No. 841 in 2018 that requires energy market operators in their jurisdiction to allow storage resources to be utilized as capacity source. A literature review is performed on grid systems day-ahead order estimates and real-time demand scenarios from the supply chain perspective. We consider an electric grid system integrated with utility scale battery storage to maintain supply and demand balance during the peak hours, when grid encounters with the most fluctuated demands. Having integrated lithium-ion batteries with grid systems as potential capacity source, meets the real-time demand with minimum real-time orders. Integration of battery storage responds to day-ahead order error through different services such as ancillary and transmission deferral. It consequently minimizes the use of fossil fuels and low efficient real-time power generation emission. We defined all involved resources during the real-time power supply and translated them to mathematical transitions. Then we used a Polynomial linear regression to find a model that describes nonlinear relationship between demand and time. The aforementioned model can be used and simulated for the grid systems aim to implement and integrate the utility scale batteries as capacity source to compensate part or all of real-time orders. The required capacity size is adjustable for different users and their system characteristics such as demand and power dispatch time periods.

Session 2 Power and Energy Engineering

Power and Energy Engineering

Time: 10:30-12:00 August 12, 2021-Thursday (GMT-4)

Session Chair: Dr. Yasser Elsayed
Ontario Tech University, Canada

Meeting ID

940 1661 2175

GEE005

10:30-10:45

Muhammad Salman Asif, Harsimran Gill

Western Sydney University, Sydney, Australia

Blockchain Technology and Green Supply Chain Management (GSCM) – Improving Environmental and Energy Performance in Multi-echelon Supply Chains

Abstract—In this competitive and technology driven world, businesses are striving to gain benefits of environmental sustainability and energy conservation by implementing the latest technologies in their supply chains. A promising way of evaluating the environmental performance of a product or a process is Life Cycle Assessment (LCA) modelling, but the reliability of LCA results is mostly compromised due to the lack of real data from upstream and downstream supply chains. Our research aim is to drive LCA modelling through Blockchain Technology (BCT) and internet-of-things which have the capability to record reliable, transparent, and secure data from across the supply chain. The modified LCA model will provide various industries with the quantified benefits of BCT in terms of industrial emissions reduction. This conference paper reflects the 1st stage of research where we carried out a detailed literature review on potential use of blockchain technology in green supply chain management and based on the findings, we developed an integrative framework architecture for the supply chain of a supermarket product. In the next phase, the integration of BCT and LCA will be studied in food supply chains using a supermarket case study of Walmart-IBM developed blockchain consortium.

Session 2 Power and Energy Engineering

SG0013

10:45-11:00

Sirkka Porada, Leonard Schulte, Albert Moser

RWTH Aachen University, Germany

A Stochastic Approach to Generate Short-Term Feed-in Profiles of Wind Power Plants

Abstract—The integration of wind turbines into the European power system poses new challenges for grid operations. One reason for this is the volatile feed-in behavior of wind turbines. Due to various meteorological influencing factors, feed-in profiles of wind turbines show not solely fluctuations in a hourly range, but also significant gradients in the timeframe of seconds to a few minutes. These short-term fluctuations of the power feed-in can cause local problems in the power system. Most studies address the generation of synthetic feed-in profiles with of temporal resolution of 15 till 60 minutes. To assess the impact of fluctuations in shorter timeframe, this paper focus on this paper focus on the generation of feed-in profiles with a resolution of 10 seconds. For this purpose, a stochastic method is developed generating feed-in profiles for wind turbines based on a Markov Chain Monte Carlo simulation. The generated feed-in profiles suitably represent the influence of meteorological phenomena in the seconds as well as in the hourly range.

SG0008

11:00-11:15

Baptiste Boyer, Philippe Fiani, Guillaume Sandou, Emmanuel Godoy, Cristina Vlad

Laboratoire des signaux et syst`emes, Universit´e Paris-Saclay, CNRS, France

Model Predictive Control Modular Approach for Multi-Source System Management

Abstract—This paper presents a modular approach to model and control multi-source systems or networks. This method derives from an energy-based modeling approach called functional modeling in which predictive functional control algorithms have been implemented. A concept of cost function is introduced and associated to each source. The design of the control has several objectives: remain as generic as possible, satisfy the needs from the consumers and distribute flows in order to minimize the cost functions. This methodology is applied to a use case consisting in the management of an isolated production unit composed of a wind power plant and a backup battery. The system is modeled and controlled in order to ensure the active power balance between consumers needs and sources supplies.

Session 2 Power and Energy Engineering

SG0017-A

11:15-11:30

Contimi Kenfack M., Niklas Wehbring, Julian Saat

RWTH Aachen University, Germany

Benefit of High Voltage Direct Current Transmission in the Cameroonian Energy Supply System

Abstract—In Cameroon, the electricity supply system consists mainly of three non-interconnected sub-grids in the north, south and east of the country. Efforts are already underway at the national level to expand the electricity supply network over a wider area to not only provide a larger share of the population with access to electricity, but also to strengthen the existing network and thus provide a more reliable supply of electricity. Approaches are being discussed to couple and jointly operate the existing sub-grids. Due to long distances, high voltage direct current (HVDC) transmissions are also considered.

Our research aims to evaluate possibilities of coupling and reinforcing the electricity supply system in Cameroon based on economic and technical criteria. For this purpose, we have modelled the current Cameroonian transmission network including six interconnection options, which distinguish themselves in either the DC or the AC transmission technology. We have then performed load flow calculations and simulated line and power plant outages. For the evaluation, maximum loads, grid losses, and the interconnection options' ability to resupply loads after power plant outages are considered. The economic evaluation is based on annuity investment and operating costs of each grid interconnection option.

The results of the different interconnection options for the modeled electricity network show that a coupling of the three sub-grids by HVDC links is technically suitable. They have the lowest transmission losses with comparatively high power exchange between the three sub-grids and, allow loads to be resupplied for most power plant outages. AC lines, on the other hand, have a high reactive power requirement. Furthermore, the economic efficiency calculation shows that the HVDC interconnection options partially amortize the investment costs for converters due to lower loss costs and therefore HVDC lines are recommended for the connection of the sub-grids in the simulated Cameroonian network.

Session 2 Power and Energy Engineering

SG0003

11:30-11:45

Zeqing Wu, **Weishen Chu**

University of Texas at Austin, United States

Sampling Strategy Analysis of Machine Learning Models for Energy Consumption Prediction

Abstract—With the development of the Internet of things (IoT), energy consumption of smart buildings has been widely concerned. The prediction of building energy consumption is of great significance for energy conservation and environmental protection as well as the construction of smart city. With the development of artificial intelligence, machine learning technology has been introduced to energy consumption prediction. In this study, multiple learning algorithms including Support Vector Regression (SVR), Artificial Neural Network (ANN), Random Forest (RF) are developed to perform energy consumption prediction. The most appropriate machine learning algorithm for energy consumption prediction has been investigated and found to be the random forest algorithm. Based on the developed machine learning models, studies on the sampling strategy for energy consumption prediction have been conducted. It is found that the variance of data has a significant effect on the prediction accuracy, and a better prediction result can be achieved by increasing the sampling density over the data with high variance. This result can be used to optimize the machine learning algorithm for building energy consumption prediction and improve the computational efficiency.

GEE016

11:45-12:00

Shayan Dadman, **Bernt A. Bremdal**, Kristoffer Tangrand

UiT – Arctic University of Norway & Smart Innovation Norway, Norway

The Role of Electric Snowmobiles and Rooftop Energy Production in the Arctic: The Case of Longyearbyen

Abstract—The research presented here has been conducted in the Smart Charge project. It has addressed the use of renewables, e-mobility and battery charging in the Arctic as part of an effort to solicit fossil-fuelled alternatives. Of particular interest has been to determine what impact and support electric snowmobiles can provide together with local, renewable energy production. The relevance of vehicle-to-grid/building (V2G/B) solutions have been investigated in the project too. The idea has been to use electric snowmobiles for load shaving during extensive periods of the year. The research has looked at cost aspects, value stacking, climate impact as well as aggregated effects of controlled fleet management of idle snowmobiles. A case study undertaken at Longyearbyen at Svalbard, Norway has provided the most important empirical basis for the research presented. The research concludes that electric snowmobiles can have a positive effect on the local energy system and despite limited range can be quite attractive for the individual to operate if energy for charging is based on local solar power.

Session 3 Photovoltaic System and Renewable Energy

Photovoltaic System and Renewable Energy

Time: 13:00-14:45 August 12, 2021-Thursday (GMT-4)

Session Chair: Assoc. Prof. Jennifer McKellar
Ontario Tech University, Canada

Meeting ID

982 1787 4488

GEE017

13:00-13:15

June Raymond L.
Mariano, Mingyu Liao, Herchang Ay

National Kaohsiung University of Science and Technology, Taiwan

Application of Grey Model in Long-Term Solar Energy Forecasting: A Case Study in Taiwan

Abstract—Promoting green energy is one of the main goals of Taiwan, and the key objective is to increase the renewable sources of energy supply by 2025. To achieve the government's plan, solar energy forecasting plays a critical role in attaining the conversion of solar irradiance to useful output power. In this study, monthly solar irradiance is used in the GM(1,1) to forecast six years of solar irradiance data at two locations in Taiwan, one at Weather Station (467440) in Kaohsiung and another at St John's University (SJU) in Tamsui. The MAPE rates of historical and predicted GHI for the weather station is 6.28%, while SJU is 10.56%. Uncertainties pose the main difficulty in solar energy forecasting, leading to an increase in prediction errors. Based on the MAPE scores, solar energy forecasting from 2020 to 2025 is highly feasible, producing satisfactory to excellent prediction accuracy. This study ascertains the high potential of achieving Taiwan's clean solar energy target, while the GM(1,1) serves as a useful forecasting method for long-term solar irradiation in Taiwan.

Session 3 Photovoltaic System and Renewable Energy

GEE011

13:15-13:30

Raed Alahmdi,
Abdulrahman Alansari,
Mohanad Abualkhair,
Abdulrahman Almoghamisi

King Abdullah University of Science and Technology, Saudi Arabia

Empirical Evaluation of Fixed and Single-Axis Tracking Photovoltaic System; Case of ASHRAE Solar Radiation Modelling for Medina, Saudi Arabia

Abstract—The main problem in studying the feasibility of solar systems is the enormous gap between theory and experimental radiation intensity, so to get accurate results there is a need for studying energy production in the site of the system empirically. In this study, the energy production of both fixed PV panel system and the system with single-axis tracking were empirically evaluated in Medina, Saudi Arabia. The two systems had the same 270 Wp PV panel. The fixed system was tilted by 23.5 degrees, and the single-axis tracker was tilted by 26 degrees. Both systems had an azimuth angle of zero degrees. A closed-loop three-points controller was used to control the tracker with 120 degrees rotation range. The two systems operated simultaneously in July, and the data were collected for 14 days. The empirical results showed that the tracker increased the generated energy by 48.5% during the testing period. As a comparing method, a modified ASHRAE model was used to estimate the increase in the panel's energy output with and without the single-axis tracker, and RMSE and MBE were calculated. It's been found that the experimental energy generation is 10%, 5% less than the estimation of the modified model for the fixed system and the tracking system, respectively. Finally, based on the analysis, it's been estimated that the single-axis tracker will increase the generated energy by 22.5% yearly in Medina.

SG0006

13:30-13:45

Farhad Khosrojerdi,
Stéphane Gagnon, **Raul Valverde**

Concordia University, Canada

Full Shading for Photovoltaic Systems Operating under Snow Conditions

Abstract—Photovoltaic (PV) installers and non-technical solar energy consumers use PV planning software for the system design and simulation. End-users rely on the designed system and power estimations provided by these tools. However, most planning software products fail to consider shading conditions. This problem affects energy forecasting for solar power plants located in cold climates. In this paper, we define the status of full shading for a snow-covered panel and the minimum depth of snow creating it. Using a case study, we design the project by the most reliable planning software, System Advisor Model (SAM). We show that the simulation overestimates power generations for snowy months. To identify shading conditions and correlated performance reductions, we compare the SAM results with the measured data collected onsite. As a result, the minimum depth of snow that can create full shading and zero production is detected. Moreover, comparing the measured data with the simulated power helps us to define a rule-base system providing PV performance reduction factors. It assists solar sector practitioners to plan a PV project accurately, especially for locations where snowfall is an important environmental factor for several months.

Session 3 Photovoltaic System and Renewable Energy

GEE015

13:45-14:00

Lucía García Gómez, Susana Luque, A. M Gutiérrez, J. R Arraibii

R&D Technician at ICUBE, University of Oviedo, Spain

Implementing of a Usable Tool for Selecting Operations to Upgrade Biogas to Biomethane

Abstract—Although biomethane is a real alternative to natural gas and a clean way to valorise biogas, in Spain they are still starting to be considered as an alternative to natural gas. A good way of promoting these renewable energies is supporting small and cheap treatment plants near to the place where the biogas is produced and where the biomethane can be used on site, fostering the circular economy. An easily usable simulation tool for selecting the best sequence of unit operations for treating biogas has been designed. Modelized operations are absorption (with water, chemical and physical), PSA, membranes, and dehydration. The tool gives information about costs, consumptions, and environmental impact of each selection. Pollutants modelled are CO_2, CH_4, NH_3, SH_2, CO_2, O_2, N_2, H_2O and siloxanes. Some alarms have been settled to help user to make a correct selection. This tool was used as first step to design a flexible and portable prototype for treating small flows of biogas as those produced in livestock which has been later built and is on operation. This kind of solutions could help the deployment of biomethane in Spain and help installations to reduce its emissions by valorising a residue.

Session 3 Photovoltaic System and Renewable Energy

GEE007

14:00-14:15

Md Azmot Ullah Khan, Naheem Olakunle Adesina, Jian Xu

Louisiana State University, USA

Photo Effect Studies in Graphene/n-GaAs Schottky Junction Using NEGF Method for Photovoltaic Application

Abstract—In this paper, we present the photovoltaic characteristics of nanoscale Schottky junction solar cell consisting of graphene and GaAs using numerical simulation based on non-equilibrium Green's function formalism. In our model, light-matter interaction is formulated by the coupling and scattering self-energy matrices whereas heterostructure is designed with a Hamiltonian matrix. An efficiency of 2.36% is obtained for monolayer graphene on GaAs; the efficiency is later enhanced to 5.40% by increasing the number of graphene layers and the doping concentration of GaAs. The parameters to calculate power conversion efficiency, series and shunt resistances are extracted from the J-V characteristic. The I-V characteristic is also numerically simulated to extract reverse saturation current, ideality factor, and rectification ratio. Moreover, the power density is calculated for the optimized structure; the maximum power density of 7.46 mW/cm^2 is obtained for four layers of graphene and a doping concentration of $1017/cm^3$ in GaAs.

GEE018-A

14:15-14:30

Tahar Tafticht, Md. Jahidur Rahman, Mouctar Tchakala

University of Québec in Abitibi-Témiscamingue(UQAT), Canada

Estimation of Optimal Operating Points in Photovoltaic Power Systems Under Partial Shading Conditions

Abstract—The photovoltaic module under partial shading which can be due to trees, neighboring buildings, clouds and many more circumstances can be there, works as a load instead of working as a generator. So, in photovoltaic array curve we do not get a unique maximum power point (MPP) but receive several local peaks and one global peak (GMPP). In the algorithms of optimum search for the MPP (maximum power point) in photovoltaic power systems under partial shading condition met in the literature, cannot locate real MPP and get stuck with local MPP. The objective of this work is to propose a new soft computing technique to track the GMPP. In this technique, Genetic Algorithm is embedded in hill climbing algorithm, which creates a single algorithm. The configuration of algorithm is designed, simulated and evaluated and their performance was compared with other literature techniques to study their capability to track the GMPPT under partial shading conditions. This approach made a possible to largely improve the tracking accuracy of the GMPP in PV systems.

Session 3 Photovoltaic System and Renewable Energy

SG0043

14:30-14:45

Amleset Kelati, Hossam Gaber

Royal Institute of Technology, Sweden

IoT and Smart Grid for Energy Management Techniques on FPGA

Abstract—In this paper, we present and discussed Internet of Things (IoT) based smart grid (SG) using smart meter (SM) for energy management techniques on Field Programmable Gate Arrays (FPGA). The SG allows for reliable communication and an efficient energy management system. IoT-based SG technology can manage and monitor remotely using Home Area Networks (HANs) for home energy management. HAN is equipped with SM to collect a huge amount of data from appliances to report their energy consumption. Home Energy Management's (HEM's) have the advantage of offering real-time energy usage to the consumer by limiting the power requirement to the SG. The paper addresses HAN system devices using ZigBee makes wireless communication effective for monitoring consumer's daily routine and by alerting security alarms with lower cost. The ZigBee network in connection with the microcontroller and interfaced with FPGA on HAN advanced the existing remote energy management system and the relatability and confidentiality of the SGs on the home energy management system.

Session 4 Electrical Engineering and Automation

Electrical Engineering and Automation

Time: 13:00-14:45 August 12, 2021-Thursday (GMT-4)

Session Chair: Assoc. Prof. Namdar Saniei
Ontario Tech University, Canada

Meeting ID

940 1661 2175

SG0022

13:00-13:15

Harmanpreet Singh Sekhon, Pawan Rathore, Vaman Dommeti

CG Power and Industrial Solutions Limited, India

Case Study on Effect of Transformer Rating on Impulse Voltage Distribution in Windings

Abstract—The design of Power transformers are basically governed by certain vital parameters: Transformer rating in kilo Volt Amperes (kVA), frequency, Voltage ratings and ratio, tapping range, Impedance values, Losses, Temperature rises, Insulation levels, Sound levels etc. The domain of this paper is specifically focused on difference in winding design of same voltage class based on different kVA ratings of transformer. The major change is related to design and type of high and intermediate voltage windings with respect to impulse voltage distribution characteristics across windings. The impulse voltage distribution which is initially based on series and ground capacitance of windings is relatively more non-linear for Low kVA transformers as compared to high kVA transformers for same voltage classes. The results of impulse distribution validating relatively poor safety margins for intermediate voltage winding in low kVA transformer have been discussed. The challenges and results are based on example of 10,000 kVA 225/132/33kV Power Transformer taking reference of 132kV winding and comparison has been established with 60,000 kVA Power Transformer of same voltage class.

Session 4 Electrical Engineering and Automation

SG0041

13:15-13:30

Marouane EL Azzaoui

Ibn Zohr University,
Morocco

Start-up and Smooth Grid Connection of the Doubly Fed Induction Generator

Abstract—This paper deals with the start-up and smooth grid connexion of the doubly-fed induction generator (DFIG) system driven by the wind turbine. Stator flux-oriented control for backto-back converters in the DFIG rotor circuit is presented. The start-up procedure of DFIG begins with the encoder calibration and ends with the grid connection. First, a new algorithm for estimating the initial rotor position is investigated. This algorithm is provided to determine the initial angle, whatever the rotor state (blocked or in rotation). Then, the synchronization of open stator and grid voltages is discussed in depth. By controlling d-axis and q-axis the magnitude and phase of the induced stator voltage are adjusted respectively to be equal to the grid voltage. The proposed method ensures a smooth connection and zero exchange power at the moment of connection. Furthermore, the steps for safe disconnection are presented. Finally, the overall methodology is validated on a 3 kW DFIG laboratory setup.

GEE006

13:30-13:45

Mahdi Boukerdja, Youness Radi, Omprakash, Sumit Sood1, Belkacem Ould-Bouamama, Anne-Lise Gehin, Jean-Yves Dieulot, Aissa Chouder, Mathieu Bressel

CRISTAL UMR CNRS 9189.
Université de Lille, France

LFT Bond Graph for Online Robust Fault Detection and Isolation of Hybrid Multi-Source System

Abstract—Green hydrogen is undoubtedly the most promising energy vector of the future because it is captured by renewable and inexhaustible sources, such as wind and/or solar energy, and can be stored over the long in high-pressure cylinders, which can be used to feed the fuel cells to produce the electricity without emitting any pollutants. The system incorporated renewable sources and process used to produce the green hydrogen is the hybrid multi-source system (HMS). The production of hydrogen needs a reliable HMS, which always requires online monitoring for real-time Fault Detection and Isolation (FDI) because the risk of accidents in HMS and safety issues increases due to the possibility of faults. However, online monitoring of FDI is challenging due to the multi-physics dynamics of HMS and the inclusion of uncertain parameters and several disturbances. This paper proposes an online robust fault detection algorithm to detect system faults based on the properties of the graphical linear fractional transformation bond graph (LFT-BG) modeling approach. Here, the analytical redundancy relations (ARRs) and their uncertain parts extracted from the LFT-BG model are used to develop an online robust FDI algorithm for HMS. Numerical evaluations of ARRs and their uncertain parts, respectively, generate the residual signals known as "faults indicators" and their uncertain bounds known as "adaptive thresholds." These thresholds evolve with system variables in the presence of parameter uncertainties for ensuring robust FDI for HMS to minimize false alarms. The validation of this approach is carried out using 20sim software that is familiar with BG modeling.

Session 4 Electrical Engineering and Automation

SG0007-A

13:45-14:00

Emilio C. Piesciorovsky, Marissa E. Morales Rodriguez, Nisha Srinivas, Aaron Wilson

Oak Ridge National Laboratory, United States

Inverse Phase-to-Ground Fault Apparent Impedance Method to Detect Type of Faults for Protective Relays, Using Signature Library and Simulated Events

Abstract—Today's electric power systems have relays that can recognize the types of faults in a few seconds with light indicators on relay front-sides. This fault-type detection method is based on measuring the angle between the zero- and negative-sequence currents, but it is not completely accurate because the phase-to-phase-ground and phase-to-ground faults have the same conditions. Therefore, engineers need to collect and plot the events after a fault to observe the nature of incidents in detail, and they cannot get an immediately identification of fault types.

In this study, the inverse phase-to-ground fault apparent impedance (IPGFAI) method was performed. This method measured the IPGFAI magnitude for the faulty and non-faulty phases, resulting in greater than zero and near zero, respectively. The IPGFAI algorithm was built with MATLAB/Simulink and validated with signature library and grid simulation events from Electric Power Board of Chattanooga utility grid circuits. The signature library mode measured the currents and voltages (26.6 kV) from optical sensors, and the grid simulation mode collected the currents and voltages (7.2 kV) from saturated measurement transformer models (MATLAB/Simulink).

The IPGFAI model was validated by the confusion matrix, collecting the true-positive and false-negative when the fault-predicted values matched and did not match the measured model values, respectively; and collecting the true-negative and false-positive when the non–fault-predicted values matched and did not match the measured model values, respectively. The measurements of the IPGFAI model matched the expected values for more than 90% of all tests, and the IPGFAI method presented an accuracy of 94.3% and precision of 100%. The IPGFAI method distinguished from the phase-to-phase-ground and phase-to-ground faults, resulting in better performance than the sequence current method.

Session 4 Electrical Engineering and Automation

SG0019

14:00-14:15

Zoya Poutmirza, Sara Walker

Newcastle University, UK

Electric Vehicle Charging Station: Cyber Security Challenges and Perspective

Abstract—The UK government has set a target to reach net zero greenhouse gas emissions by 2050, and many other countries follow the same goal. In order to support the transition to net zero carbon future, Electric Vehicles (EV) can play a significant role. Providing a secure EV charging station is of high importance as the amount and type of data handled and transmitted via EV charging stations is growing and raising concerns both for the grid and consumers. The objective of this paper is to study the current landscape of EV charging stations in terms of cyber security, identify the cyber vulnerabilities, and present protocols and standards that can address cyber security challenges in such systems to provide a more secure charging infrastructure. Finally, this paper recommends the use of some security measures and techniques to mitigate cyber-attacks on EV charging infrastructure and alleviate the adverse impact of such attacks.

SG0039

14:15-14:30

Abdalrahman Elshora, Yasser Elsayed, Hossam A. Gabbar

Ontario Tech University, Canada

Modular Bidirectional Converter with Multiple Power Sources for Fast Charging of Electric Vehicles

Abstract—Canadian transportation sector has been reported recently as the second-largest source of GHG. Therefore, researchers have been interested in developing charging control systems for electrical vehicles. The main two challenges are the size of the energy storage and the charging time. Researches prove that hybrid energy storage can increase energy density and reliability besides reducing the total cost of energy. However, managing multiple sources of energy is a big challenge. This paper introduces a bidirectional DC-DC converter that can manage hybrid energy storage composed of multiple sources of energy. It enables the modular extension of input energy sources by adding few components. It enables power flow in all possible directions. The proposed converter has been simulated by using Matlab Simulink and validated the most operating scenarios of charging and discharging successfully.

Session 4 Electrical Engineering and Automation

SG0026

14:30-14:45

Kathrine Lau Jørgensen,
Hamid Reza Shaker

University of Southern Denmark, Denmark

Wind Power Forecasting for the Danish Transmission System Operator Using Machine Learning

Abstract—A power grid with increasing wind power and decreasing capacity of conventional power plants induces challenges in the balancing of the power grid. The cost of purchasing reserves in Denmark has increased rapidly over the last five years. One solution to decrease the reserve cost is by introducing new market players to the markets, e.g. wind turbines. Today the wind turbines are excluded from the markets due to low availability. By developing a wind power forecasting model, the availability of the wind at varying wind speeds can be evaluated. A time series neural network with three hidden neurons and two delays are developed. It was found that the highest performance was reached by applying PCA and by using the training algorithm scaled conjugate gradient. The optimal network resulted in an R2-value at 0.990 and MSE at 33895, when testing the model on unseen data. Using the developed model, the availability of wind power was estimated. Limits of the reserve purchase were set at varying wind speeds. The highest purchase was at wind speeds above 20 m/s, where 92% of the predicted power is available with a security of 95%. As the wind speed decreases the purchase decreases as well. The model showed the poorest predictions at wind speeds between 0-5 m/s.

Session 5 Microgrid and Smart Grid

Microgrid and Smart Grid

Time: 10:15-12:00 August 13, 2021-Friday (GMT-4)

Session Chair: Prof. Alberto Borghetti
University of Bologna, Italy

Meeting ID

982 1787 4488

SG0034

10:15-10:30

Pegah Yazdkhasti,
Chris. P. Diduch

University of New Brunswick, Canada

Design of a Smart Controller Agent for Demand-Side Management with Low Payback Effect

Abstract—With high penetration of renewable resources such as wind and solar into conventional electric grid, new challenges are introduced due to the rapid fluctuation on the generation side. Direct load control of thermostatically controlled loads can play a significant role in demand side management (DSM) to cope with the uncertainties and variabilities of the generation. For this purpose, the system operator (SO) requires a reliable forecast of the demand and how much it can be shifted; in order to produce attainable desirable set points to reshape the demand to follow generation side. The focus of this paper is on designing a smart agent that uses a hybrid system of a model-based and a model-free structure to forecast the controllable load and its capacity to be reshaped, and follow the dispatch instructions of the SO, while minimizing the payback effect of the control actions and maintaining customers' comfort. The main advantages of the proposed system are: 1) real-time model creation; thus, no need for historical data for training, 2) model free controller can automatically adapt to the changes in the system, 3) it can be used as a plug & play component in a DSM program. To evaluate the performance of the proposed controller, a numerical simulator was developed, and the controller was applied over the simulation engine to follow arbitrary desired power profiles. It was observed that the system can follow the dispatch command in less than 5 minutes with a negligible steady state error (less than 5%).

Session 5 Microgrid and Smart Grid

SG2001

10:30-10:45

Daniela Wohlschlager, Anika Neitz-Regett, Bastian Lanzinger

Research Center for Energy Economics (FfE), Germany

Environmental Assessment of Digital Infrastructure in Decentralized Smart Grids

Abstract—This paper examines the life cycle-based direct environmental impact of information and communication technology (ICT) in German smart grids. Specifically, it explores the global warming potential associated with smart metering infrastructure and the use case of decentralized flexibility markets. Results show an annual footprint of 513,679 t CO_2 eq. for the intelligent metering infrastructure expected in low-voltage levels by 2030. Digitalization measures required for a household to provide flexibility from decentralized assets cause approx. 27 to 43 kg CO_2 eq. per household and year. Given the marginal data volume associated with the use case, the operation and production phases of hardware cause the greatest impact. Accordingly, considerable reduction potentials lie in decarbonizing the electricity mix and ensuring high energy efficiency and longevity of components. As more data-intensive use cases emerge, the method provided in this paper enables further environmental assessments of direct effects and the derivation of recommendations for a sustainable technical design. First qualitative estimations of indirect environmental effects indicate the need for subsequent research in the context of smart grids, including behavioral research and energy system modeling approaches.

SG0027

10:45-11:00

Sobhan Dorahaki, Rahman Dashti, **Hamid Reza Shaker**

University of Southern Denmark, Denmark

A Novel Probabilistic Risk-Based Energy Management Model in the Smart MicroGrids

Abstract—Nowadays, the smart MicroGrid (MG) is known as a challenging and interesting concept to effectively solve the problems and issues of the power system. In this paper, a novel probabilistic risk base optimization model has been proposed to manage the operation cost and risk cost of the smart MG. The electrical and thermal Demand Response (DR) has been considered in the proposed structure. The Probability Distribution Function (PDF) has been used to model the uncertainty of the model. Also, the K-means and Mixed Integer Linear Programming (MILP) scenario reduction methods have been used to decrease the number of scenarios. Furthermore, the objective function of the proposed optimization is modeled as MILP. The CPLEX solver in the GAMS environment is used to solve the problem. Results show that the electrical and thermal DR causes a decrease in the risk cost of the smart MG.

Session 5 Microgrid and Smart Grid

SG0040

11:00-11:15

Hussain Sarwar Khan, Khaled Syfullah Fuad, **Mazaher Karimi**, Kimmo Kauhaniemi

University of Vaasa, Finland

Fault Current Level Analysis of Future Microgrids with High Penetration Level of Power Electronic-Based Generation

Abstract—The integration of power electronics-based generation has increased in the medium voltage (MV) level of the distribution networks, nowadays. It is obvious that the contribution level of this type of source is providing a limited fault current level according to the thermal and fault ride-through capability of power electronic converters. Therefore, the fault current level in the grid-connected and islanded mode of the microgrid is different and the protection scheme is required to be reviewed. In this regard, converters' responses contribute to the stability of the microgrid in the case of abnormal conditions. This paper has investigated the effect of power electronic converters and their controllers in future microgrids with the high penetration level of power electronic-based generation. A distribution management system has been designed to address the issues and challenges of faulty conditions and a voltage ride-through technique has been proposed. The simulation results of an MV distribution network demonstrate the fault current level of the future microgrid in abnormal conditions. The proper protection strategy is designed to detect any type of short circuit fault current as well as avoidance of damage to the integrated PEC-based generations.

SG0011

11:15-11:30

Farhad Khosrojerdi, Stéphane Gagnon, **Raul Valverde**

Concordia University, Canada

Applications of Artificial Intelligence in Smart Grids: Present and Future Research Domains

Abstract—In the last decade, Artificial Intelligence (AI) have been applied overwhelmingly in various research domains in the context of smart grid. It has been one of the main streams of advanced technological approaches that the research community offered for developing smart grids. However, the broad scope of the subject matter launch complexity for scholars to identify effective research approaches. In this paper, we present a literature review about utilizing AI in the key elements of smart grids including grid-connected vehicles, data-driven components, and the power system network. This will result in highlighting technical challenges of the integration of electric vehicles to the grid and the power network operation as well. Moreover, we discuss the four key research areas in the context of AI and its applications in intelligent power grids. The proposed research fields aid PhD candidates to consider these areas as the promising domains for investigation.

Session 5 Microgrid and Smart Grid

SG0009

11:30-11:45

Saeed Rezaee, Amr Radwan, Mehrdad Moallem, Jiacheng Wang

Western Washington University, USA

Stability Analysis of a Remote DC Subgrid/Microgrid Connected to a Very Weak AC Grid

Abstract—Instability issues can arise due to the high penetration of remote voltage source converter (VSC)-interfaced DC microgrid (MG) to the ac weak grid (WG), in which the grid impedance is large. This is due to the dynamic interaction between the VSCs and the WG impedance. In this work, a small-signal analysis is conducted to derive the full-order linearized model of the VSC-WG interconnection. Furthermore, a participation factor analysis is presented to identify the effect of varying the grid impedance on the VSC-WG dominant modes in the inversion and rectification modes of operation. It is found that although the system is initially stable in both modes, it tends to move toward the unstable region when the grid impedance increases. In this study, the initial locations of the corresponding dominant eigenvalues are fairly similar for both modes. However, unlike previous works, it is shown that the dominant modes in the rectification mode are much more sensitive to the grid impedance variation than the inversion mode. Time-domain simulations are conducted on a 7.25 MW dc MG which is interfaced to the ac grid via a VSC system to verify the validity of small-signal analysis in both modes.

SG0020

11:45-12:00

Ugonna Chikezie, Tutku Karacolak, Josue Campos do Prado

Washington State University, United States

Examining the Applicability of Blockchain to the Smart Grid Using Proof-of-Authority Consensus

Abstract—Security has been a major challenge in the smart grid since its adoption. This great concern let to the proposal of the application of blockchain technology to the smart grid. Blockchain is a growing list of records, called blocks, that are linked using cryptography and its transactions are validated by a consensus mechanism. The most known and trusted blockchain consensus mechanism is the proof-of-work (PoW) as it can process very little number of transactions per second. However, the proof-of-authority (PoA) consensus mechanism is scalable as it can process thousands of transactions per second without compromising security. This paper focuses on the applicability of blockchain PoA consensus mechanism and how it ensures that transactions are confirmed on time and the integrity of the transactions are upheld in the blockchain. The PoA consensus mechanism is appropriate especially with the adoption of peer-to-peer energy trading between prosumers and consumers. This study proposes a peer-to-peer energy trading in an open blockchain with the help of the Advanced Metering Infrastructure (AMI) that enables smart meters to function optimally for this purpose.

Session 6 Electronics and Power System

Electronics and Power System

Time: 10:15-12:00 August 13, 2021-Friday (GMT-4)

Session Chair: Assoc. Prof. Othman Nasri
ENISO / University of Sousse, Tunisia

Meeting ID

940 1661 2175

SG0012

10:15-10:30

Abhishek Varshney, **Renuka Loka**, Alivelu M. Parimi

Birla Institute of Technology and Science, Pilani-Hyderabad Campus, India

Fast Frequency Response Using Model Predictive Control for A Hybrid Power System

Abstract—Large-scale penetration of Renewable Energy Sources (RESs) in Hybrid Power Systems (HPSs) consists of predominantly asynchronously interfaced sources. Asynchronous interconnection of RESs is made possible by using Power Electronic Converters (PECs); however, it subsequently reduces the system inertia due to less rotational mass. The decrease in system inertia causes a high Rate of Change of Frequency (RoCoF). Consequently, frequency control becomes challenging with high RoCoF. To maintain the frequency at a nominal value, the power balance between the load and generation is necessary. The excess or deficit in power from RES is uncertain, and stochastic load disturbances should match generation and storage changes. Owing to high RoCoF, the response of the system to maintain power balance should be obtained within a minimum time. Therefore, Fast Frequency Response (FFR) using the available reserves is of prime significance. This paper addresses the FFR problem by proposing a modified Model Predictive Control (MPC) by introducing RoCoF in the objective function to achieve FFR using primarily Fuel Cell (FC) storage in a Hybrid Power System (HPS). The modified MPC controller's performance is compared with the conventional PID and MPC controllers by testing the dynamic model for both situations - i) constant step and ii) random load fluctuations and wind disturbances using MATLAB/Simulink. Simulation results under various cases show that the proposed MPC has improved the performance parameters (settling time, peak overshoot, and peak-peak magnitude) of the step response.

Session 6 Electronics and Power System

SG0028

10:30-10:45

Tianjian Wang, Ying Wang, Yan Hou, Fei Gu, Wei Jin, Lin Liu

Substation Operation and Maintenance Centre, State Grid Zhengzhou Power Supply Company, China

Optimization of Unbalanced Active Distribution Systems Using Cuckoo Search Algorithm

Abstract—These years, the connection of distributed generation (DG) to active distribution systems or microgrid has been widely used. The DGs integration and the novel optimization algorithms, makes the realization of optimal power flow (OPF) at the distribution level feasible. OPF not only reduces system power losses, but also decreases the DGs generation costs; simultaneously, the new control strategy improves the voltage profiles, which is a significant factor of power qualities. In this paper, a multi-objective function is converted into a single objective problem that defines a nonlinear power flow for optimization. Cuckoo Search (CS) algorithm is put into used.

SG0021

10:45-11:00

Austin Lassetter, Eduardo Cotilla-Sanchez, Jinsub Kim

Oregon State University, USA

Using Critical Slowing Down Features to Enhance Performance of Artificial Neural Networks for Time-Domain Power System Data

Abstract—This paper explores deep learning approaches to event classification on real world time-domain power system data. We use a statistical method to measure a physical phenomenon known as critical slowing down (CSD) and use this as a feature engineering preprocessing framework to localize events from large intervals of data. Several previous works have discussed power system event detection, including statistical methods like correlation, Principal Component Analysis (PCA) reconstruction, and local outlier factor search. This work aims to improve upon the statistical methods that have been linked to high-sample rate time-domain event detection and then will be evaluated using artificial neural networks. To evaluate how well CSD localizes events from non-events in high sample rate time-series data, we used a Z-score function to predict the time of an event and extract a six second interval centered around the prediction. The performance of CSD-applied data against the raw data was then compared using two ANN architectures: the Fully Convolutional Network (FCN) and the Residual Neural Network (ResNet). The results of both architectures demonstrate that applying CSD to the data significantly improves event localization for larger data intervals, thus signifying an improvement in event detectability.

Session 6 Electronics and Power System

SG0031

11:00-11:15

Miguel Jiménez Aparicio, Matthew J. Reno, Pedro Barba, Ali Bidram

Sandia National Laboratories, US

Multi-resolution Analysis Algorithm for Fast Fault Classification and Location in Distribution Systems

Abstract—This paper presents a new method for fault classification and location based on the Discrete Wavelet Transform decomposition and signal reconstruction - a type of Multi-Resolution Analysis. The designed signal-processing stage, which encompasses various signal transforms, plus the aforementioned decomposition in several frequency bands and the calculation of the signals' energy, provides a consistent generalization of the features that characterize the fault signal. Then, this data is fed into ensemble Machine Learning algorithms. The results show that this method is reasonably accurate while requiring a tiny amount of fault data, expanding the capabilities of Traveling Wave relays to achieve an accurate fault classification and location in just microseconds.

SG0010

11:15-11:30

Atieh Delavari, Jacques Prevost, Alain Cotey

Hydro Qu´ebec Research Institute (IREQ), Varennes, Canada

Hydro-Quebec's Experience of Implementing Power-System Node-Breaker Model for Planning Studies

Abstract—To meet new needs and to respond to changes in the energy market, Hydro-Que´bec Trans E´ nergie (HQT) undertakes an important research project, named PRIAD, to improve existing tools for asset management and modelling system. The aim of this project is to assess the impact of the unavailability of equipment, such as breakers, sectionalizers, physical buses, power transformers, etc., on the performance of the Hydro-Quebec (HQ) network. Power system node-breaker (PSNB) models are of common use in operation, while bus-branch models are usually used in planning studies. PRIAD relies on a transmission system reliability simulator named PRISME. PRISME is HQ's first planning application that requires a PSNB model. To this end, we have developed an algorithm to convert the traditional busbranch network model to a detailed node-breaker representation. To generate the node-breaker model (PSS/E format), we used the state estimator file in IEEE format, the Energy Management System (EMS) network connectivity model (CIM format), and the state of switches from the Supervisory Control and Data Acquisition System (SCADA) file.

Session 6 Electronics and Power System

GEE014

11:30-11:45

Amin Ziagham Ahwazi, Chiara Bordin, Sambeet Mishra, Phuong Hoai Ha, Alexander Horsch

UiT – The Arctic University of Norway, Norway

VEDA - moVE DAta to Balance the Grid: Research Directions and Recommendations for Exploiting Data Centers Flexibility within the Power System

Abstract—This paper aims at discussing visions and research directions to investigate the value of data centers flexibility within sustainable electrical energy systems. While optimizing the energy consumption and task scheduling within data centers located in different time zones and connected at national and international level, it is possible to balance the local power grids, to allow a better penetration of intermittent renewable energy sources, and a more economical way to address peak demand by avoiding or postponing costly investments in network expansion. Challenges and opportunities that lie behind the exploitation of data centers flexibility within sustainable electrical energy systems will be discussed. An interdisciplinary approach to tackle these kinds of problems will be proposed, and visions for a novel framework called VEDA (moVE DAta to balance the grid) will be outlined.

SG4001

11:45-12:00

Regad Mohamed, Billal boudy, Hossam A. Gabbar

Ecole Supérieur Polytechnique (ESP), Mauritanie

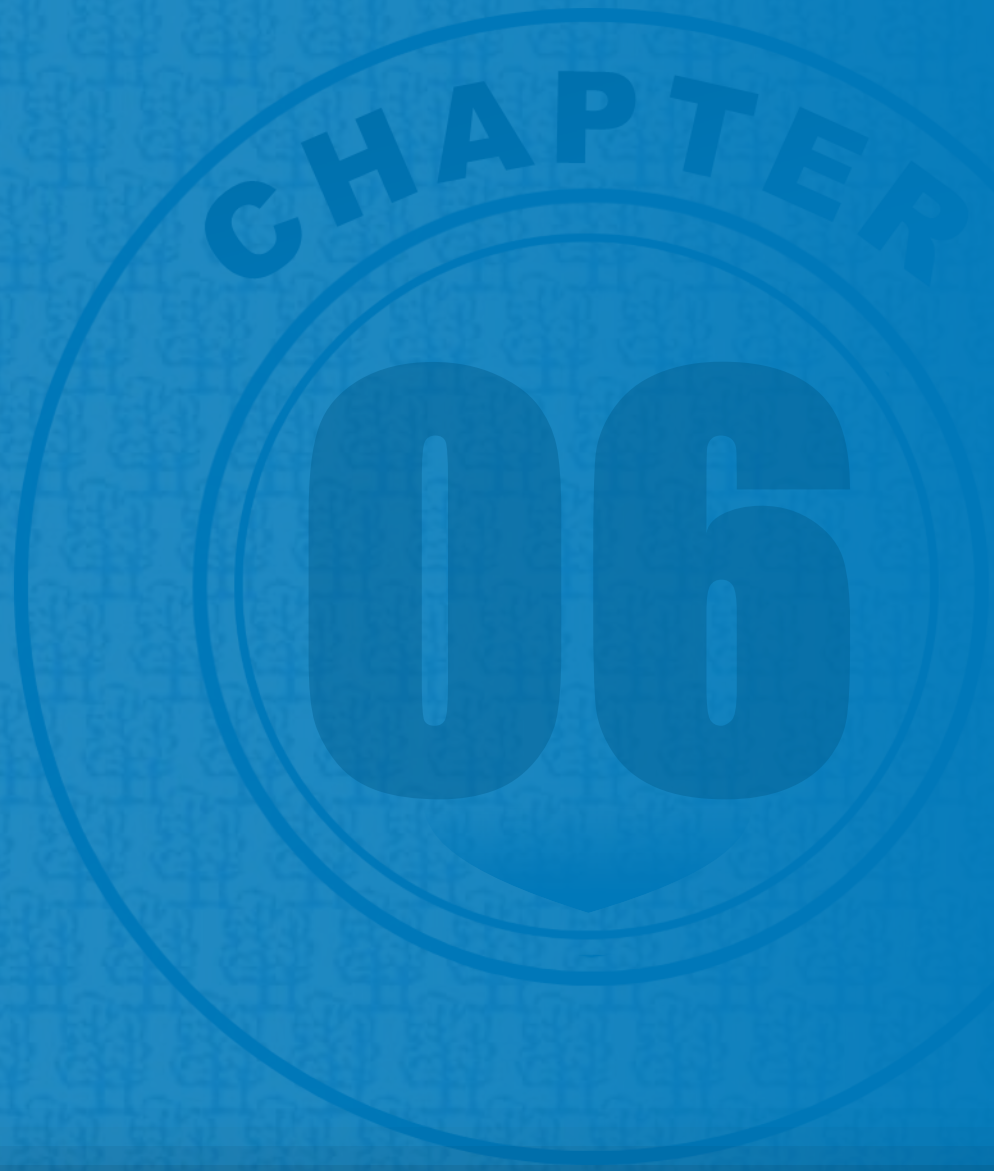
Fractional PID Controller Tuning Using Krill Herd for Renewable Power Systems Control

Abstract—This paper addresses the optimization of the Fractional Order PID controller (FOPID) parameters used to control the frequency and power deviation of hybrid power system based renewable energy generation. This proposed system is consisted of renewable energy generation like wind and photovoltaic system with conventional sources such as diesel generator and fuel cell along with Energy Storage Systems (Battery Energy Storage Systems (BESS) and Flywheel Energy Storage Systems (FESS)). The Krill Herd algorithm is used to determine the gains parameters of the Fractional Order PID controller. The scope of this paper is to eliminate the frequency and power deviation to provide the stability of the proposed system. The obtained results show that the proposed controller enhances the system stability performance in comparing with PID controller.

06

Panel Session

- Panelist in ‘Transitioning of Hydrogen Energy Infrastructures and Community Applications’



Panel Session

Meeting ID: 982 1787 4488 Time: 15:00-16:30 (GMT-4), Aug. 12

Assoc. Prof. Daniel Hoornweg

Ontario Tech University, Canada

Dan is Associate Professor, Associate Dean and Richard Marceau Chair at Ontario Tech University. Following almost 20 years with the World Bank, including as Lead Advisor overseeing Sustainable Cities and Climate Change programs, Dan returned to Ontario, Canada. Dan has worked directly with more than 350 local governments, private companies and public agencies. Dan was the Chief Safety and Risk Officer for the Province of Ontario 2012-2020 (Technical Standards and Safety Authority, TSSA).

Dan's academic background includes degrees in Earth Sciences (University of Waterloo), a Masters in Environmental Engineering (Guelph) and a PhD in Civil (Sustainability) Engineering (University of Toronto, 2015). Dan researches energy and material flows of cities and urban systems. He is active in researching and advising on energy transitions as jurisdiction strive for ‘net-zero carbon’ energy systems by 2050.

Panel Session

Meeting ID: 982 1787 4488 Time: 15:00-16:30 (GMT-4), Aug. 12

Prof. Michael W Fowler

Department of Chemical Engineering,
University of Waterloo, Canada

Dr. Michael Fowler is a Professor in the Department of Chemical Engineering at the University of Waterloo with a research interest in electrochemical power sources. Specifically his research focuses on fuel cell system design and reliability, fuel cell and battery materials durability and green power systems. His research includes modelling of hydrogen production and distribution systems, including Power-to-Gas. With the University of Waterloo Alternative fuel team he is the co-advisor of the development of a number of fuel cell and plug-in hybrid vehicles. The University of Waterloo is one of Canada's leading comprehensive universities with extensive graduate and undergraduate programs.

- 170 peer review Journal Papers, 11,470 citations – h-Factor 62 (Google Scholar) https://scholar.google.com/citations?user=hUUCkoMAAAAJ&hl=en&authuser=1
- Canada Research Chair Tier I – Zero-Emission Vehicles and Hydrogen Energy Systems
- Engineering Teaching Award – 2012
- Faculty Advisor for 11 Student Design Competitions (H2U – Hydrogen Design, ECOCAR 1-4)
- Research interest specific to electrochemical energy storage, specific batteries, and fuel cells

Panel Session

Meeting ID: 982 1787 4488 Time: 15:00-16:30 (GMT-4), Aug. 12

Dr. Rupp Carriveau

University of Windsor, Canada

Dr. Rupp Carriveau is the Director of the Environmental Energy Institute and Co-Director of the Turbulence and Energy Lab at the University of Windsor. His research activities focus on energy systems futures. Dr. Carriveau serves on the Editorial Boards of Wind Engineering, Advances in Energy Research, and the International Journal of Sustainable Energy. He recently Guest-Edited special editions of Energies and The Journal of Energy Storage. Professor Carriveau was a recent recipient of the University Scholar Award and has acted as a Research Ambassador for the Council of Ontario Universities. Dr. Carriveau is a Founder of the Offshore Energy and Storage Society (OSES) and recently Co-Chaired OSES2018 Ningbo China, and OSES2019 Brest France. Professor Carriveau is Chair of the IEEE Ocean Energy Technology Committee and was just named to Canada's Clean50 2020 for his contributions to clean capitalism.

Meeting ID: 982 1787 4488 Time: 15:00-16:30 (GMT-4), Aug. 12

Dr. Robert Stasko

Board Chair of Hydrogen Business Council (HBC)

Robert (Bob) Stasko is a business development professional providing management consulting services focused on developing and implementing clean-tech energy solutions. He is an energy technology specialist who has held management positions in R&D, product development, market analysis and collaborative pilot projects. He has worked on major policy initiatives for governments and corporate clients in Ontario & Canada.

Thank You for Attendance!

Please stay safe, and hope to
see you next year.