Electrimacs 2022 scientific program

MONDAY 16 MAY

	R. 201	R. 202	R. 204
13:00	Registration / welcome desk		
14:00	Tutorial 1	Tutorial 2	Tutorial 3
16 :00			
18:45	Registration / welcome desk		
19:30	Welcome reception		
21:30			

TUESDAY 17 MAY

	R. 201	R. 202	R. 204
07:30	Registration / welcome desk		
08:30	Opening session		
09:00	Plenary 1		
10:00	Coffee break		
10:30	TT3 - 1	TT1 - 1	TT4 - 1
12:30	Lunch		
14:00	Plenary 2		
15:00	Transfert		
15:20	SS2	SS3	TT2 - 1
16:20	Coffee break		
16:50	SS7	TT1 - 2	TT4 - 2
18:10			
18:30	City tour of Nancy		
19:45			

WEDNESDAY 18 MAY

	R. 201	R. 202	R. 204
08:30	Registration / welcome desk		
09:00	Plenary 3		
10:00	Coffee break		
10:30	TT4 - 3	TT3 - 2	TT1 - 3
12:30	Lunch		
14:00	SS4 - 1	IMACS TC1 meeting	SS10 - 1
16:00	Coffee break		
16:30	SS5	TT3 - 3	TT2 - 2
18:10			
19:30	Social dinner		
23:30			

THURSDAY 19 MAY

	R. 201	R. 202	R. 204
08:30	Registration / welcome desk		
09:00	Plenary 4		
10:00	Coffee break		
10:30	SS4 – 2	SS10 – 2	TT3 - 4
12:30	Closing session		
13:30			

Last modifications on April 29, 2022

DETAILED PROGRAM

MONDAY 16 MAY

	ROOM 201	ROOM 202	ROOM 204
13:00	Registration / Welcome desk (60')		
14:00	Tutorial 1 Christophe Turpin	Tutorial 2 Giovanni Spagnuolo	Tutorial 3 Ilhem Slama-Belkhodja
16:00			
18:45	Registration / Welcome desk (45')		
19:30	Welcome reception		

TUESDAY 17 MAY

	ROOM 201	ROOM 202	ROOM 204
07:30	Registration / Welcome desk (60')		
08:30	Opening session (30')		
09:00	Plenary 1 Florent Nierlich (60')		
10:00	Coffee break (30')		
10:30	**TT3 - 1**	**TT1 - 1**	**TT4 - 1**
	388448 – Al Ameri	385891 - Cizeron	385568 - Aouad
	380857 - Benyahia	386542 - Haghgooei	382097 – Ben Ghorbal
	389230 - Azib	382108 - Makki	386740 - Kadri
	385726 - Jday	389830 - Masoom	389495 - Khefifi
	383065 – Cardo-Miota	383842 - Trajin	389034 - Mustika
	389610 - Hajar		382165 - Ouaba
12:30	Lunch (1:30)		
14:00	Plenary 2 Babak Nahid-Mobarakeh (60')		
15:00	Transfert (20')		
15:20	**SS2**	**SS3**	**TT2 - 1**
	388621 - Jacobs	390669 – La Tona	389571 - Taha
	389243 – Colmenero Moratalla	388830 – Cabrera-Tobar	388852 - Farooq
	385868 - Oumaziz	388823 – D'Amore	389626 - Pordanjani
16:20	Coffee break (30')		
16:50	**SS7**	**TT1 - 2**	**TT4 - 2**
	389485 - Igourzal	389678 - Togni	389593 - Rashidirad
	389727 - Villaume	389606 - Bouach	389725 - Mahrasa
	388633 - Ghaderi	384962 - Pichon	387845 - Radet
18:10	386000 - Moghadari	399122 - Shourick	385567 - Hennane
18:30 19:45	City tour of Nancy (1:15)		

Last modifications on April 29, 2022

	WEDNESDAY 18 MAY		
	ROOM 201	ROOM 202	ROOM 204
08:30	**Registration / Welcome desk (30')**		
09:00	**Plenary 3** **Zi-Qiang Zhu (60')**		
10:00	**Coffee break (30')**		
10:30	**TT4 - 3**	**TT3 - 2**	**TT1 - 3**
	389752 - Dellaly	389447 – Martinez-Turegano	385730 - Pniak
	389658 - Dekali	385498 - Hoang	385603 - Vitale
	388885 – Rigo-Mariani	383057 - Belenguer	385541 - Stoyka
	389607 - Rashidirad	381018 - Roux	382596 - Sabrié
	389562 - Luna	385533 - Amoros	399111 - Nazer
	388763 – Van Wayenberge	385244 - Putratama	388953 - Abbasi
12:30	**Lunch (1:30)**		
14:00	**SS4 - 1**	**IMACS TC1 meeting**	**SS10 - 1**
	390297 - Russo		389109 - Alyafi
	387751 - Mattia		389837 - Petit
	390065 – Airo Farulla		394559 - Pietrzak
	389048 - Trovo		384158 - Berghout
	387555 - Albuquerque		380810 – Hologne-Carpentier
	386248 - Vaidya		388801 - Dini
16:00	**Coffee break (30')**		
16:30	**SS5**	**TT3 - 3**	**TT2 - 2**
	388709 - Boukir	387948 - Rouphael	382297 - Diab
	388558 - Hodencq	389191 - Gavagsaz-Ghoachani	381950 - Bergeron
	389768 - Chauwin	387344 - Pang	388955 - Hatoum
	397961 – Valinataj Bahnemiri	384908 - Lappalainen	382065 - Schuller
18:10	389704 - Gharifi	388640 - Utrilla	390117 - Diab
19:30 23:30	**Social dinner**		

Last modifications on April 29, 2022

	THURSDAY 19 MAY		
	ROOM 201	ROOM 202	ROOM 204
08:30	Registration / Welcome desk (30')		
09:00	Plenary 4 Marco Liserre (60')		
10:00	Coffee break (30')		
10:30	SS4 – 2	SS10 – 2	TT3 - 4
	385892 - Rabab	394693 - Skowron	388136 - Merai
	389813 - Celades	388911 – Guedes Almeida	388485 - Dassonville
	389418 - Lefranc	385169 - Petrone	385676 - Nguyen
	381964 - Vendrame	388766 - Ramos	389494 - Igourzal
	388401 - Lombardi	388619 - Petrusev	389280 - Siangsanoh
	388390 – Di Piazza	388875 - Becerra	389348 - El Hajj
12:30 13:30	Closing session (60')		

Last modifications on April 29, 2022

PRESENTATION INSTRUCTIONS

For all oral conferences

- Your presentation must be **in English.**
- Your presentation support must be saved as PowerPoint or PDF format on a USB key.
- If you want to use **particular formats such as video**, sending your presentation in advance is highly recommended. Using a local file is preferred rather than reading an online file.
- We invite you to load your presentation before the beginning of your session, **half a day before your presentation on the computer of your conference room.**
- To avoid any technical bug and too long installation time, it is better to **use only the computer at your disposal.** We ask that you do not use your personal computer (unless otherwise indicated).
- A remote control with laser pointer will be at your disposal.

Plenary

You will have **60 minutes** to realize your presentation
(50 minutes for presentation + 10 minutes for questions).

Tutorials

You will have **120 minutes** to realize your presentation
(90 minutes for presentation + 30 minutes for questions).

Technical Track

You will have **20 minutes** to realize your presentation
(15 minutes for presentation + 5 minutes for questions).

Special Session

You will have **20 minutes** to realize your presentation
(15 minutes for presentation + 5 minutes for questions).

Last modifications on April 29, 2022

SCIENTIFIC SESSIONS OF THE CONGRESS

COLOR	SCIENTIFIC SESSION	DETAIL
	TT1-Modelling and simulation of power electronics system ***Seiichiro Katsura**, Keio University, Dept. of System Design Engineering, Yokohama, Japan* ***Nicolas Patin**, UTC Compiègne, LEC, Compiègne, France*	**p.**
	TT2-Modelling and simulation of electrical machines and electromagnetic device ***Georges Barakat**, Université Le Havre Normandie, GREAH, Le Havre, France* ***Noureddine Takorabet**, Université de Lorraine, GREEN, Nancy, France*	**p.**
	TT3-Control and power management of electrical system ***João Pedro Trovão**, University of Sherbrooke, e-TESC Lab, Sherbrooke, Canada* ***Bruno Francois**, Ecole Centrale de Lille, L2EP, Lille, France*	**p.**
	TT4-Microgrids/smart grids ***Manuela Sechilariu**, UTC Compiègne, AVENUES, Compiègne, France* ***Bruno Sareni**, Université Paul Sabatier, ENSEEIHT, Toulouse, France* ***Maria Carmela di Piazza**, CNR, Palermo, Italia*	**p.**
	SS2-Reliability and Safety management of Power Systems ***Afef Bennani Ben Abdelghani**, University of Carthage, INSAT (National Institute of Applied Sciences and Technology), Tunis, Tunisia* ***Frédéric Richardeau**, CNRS Dir., LAPLACE, University of Toulouse, CNRS, UPS, Toulouse, France*	**p.**
	SS3-Nanogrids Architectures for Smart Buildings ***Rodolfo Araneo**, Dipartimento di Ing. Astronautica, Elettrica ed Energetica, Sapienza Università di Roma, Italy* ***Giuseppe La Tona**, Institute of Marine Engineering of National Research Council (CNR), Italy* ***Giovanni Petrone**, DIEM - Dipartimento di Ingegneria dell'Informazione ed Elettrica e Matematica Applicata, Università degli studi di Salerno, Italy*	**p.**
	SS4-Energy Storage Systems ***Giuseppe La Tona**, Institute of Marine Engineering of National Research Council (CNR), Italy* ***Massimiliano Luna**, Institute of Marine Engineering of National Research Council (CNR), Italy* ***Walter Zamboni**, DIEM - Dipartimento di Ingegneria dell'Informazione ed Elettrica e Matematica Applicata, Università degli studi di Salerno, Italy*	**p.**

TT1 TECHNICAL TRACKS

SESSION: Modelling and simulation of power electronics system

TT1. part 1	Tuesday May 17 (10:30 AM – 12:30 PM) - ROOM 202 **Chairs:** Lotfi Baghli, Université de Lorraine, GREEN, Nancy, France Farid Meibody-Tabar, Université de Lorraine, LEMTA, Nancy, France	
385891 **10:30**	20’	**PWM-Induced Current Modelling in Stator Slots with Multiple Stacked Coils.** Antoine Cizeron[1,2], Hugo Milan[3], Javier Ojeda[3], Olivier Béthoux[1,2] *1. GeePs – Université Paris-Saclay, CentraleSupélec, CNRS, Laboratoire de Génie Electrique et Electronique de Paris, France* *2. Sorbonne Université, CNRS, Group of Electrical Engineering - Paris, France* *3. Satie – ENS Paris-Saclay, Laboratory of Systems and Applications of Information and Energy Technologies, France* ***Abstract*** *This paper deals with the PWM-induced current and losses in a specific segmented winding structure. The proposed segmentation process enables to split a winding into several coils. These latter are supplied independently by H-bridge converters and are wound around the same magnetic circuit. This process allows for deeper segmentation of electric drives for enhanced modularity and reduced voltage rating. The strong magnetic coupling between each coil is described, and the control degrees of freedom are presented. This study provides a model based on an analytical method and on an equivalent electrical circuit calibrated through experimental results. A trade-off is found between the losses related either to the distribution of the fundamental component of currents or to the switching power converter supply.*
386542 **10:50**	20’	**Current Sensor Fault Tolerant Control for a Synchronous Machine Based on Stator Current Estimation** Peyman Haghgooei[1], Ehsan Jamshidpour[1], Noureddine Takorabet[1], Davood Arab Khaburi[2], Babak Nahid-Mobarakeh[3] *1. GREEN – Université de Lorraine, France* *2. Iran University of Science and Technology, Iran* *3. McMaster University, Canada* ***Abstract*** *In this study, a current sensor faults tolerant control method is proposed for synchronous machines. The proposed method is based on the estimation of the stator currents. A comparison algorithm between the estimated and measured currents allows detecting a possible fault in the current sensors. Once a fault is detected in the current sensors, the control system is switched to the current sensor-less control. This transition to sensorless control mode isachieved quickly without stopping or slowing down the rotor speed. To validate the proposed method, simulations and experimental tests are carried out on a wound rotor synchronous machine.*

382108 **11:10**	20’	**Dielectric Material Significance on Common Mode Transient Immunity of a Shielded Pulse Planar Transformer** Loreine Makki[1], Antoine Laspeyree[1], Anne-Sophie Descamps[1], Julien Weckbrodt[1], Marc Anthony Mannah[2], Christophe Batard[1], Nicolas Ginot[1] *1. Université de Nantes, France* *2. International University of Beirut BIU, Lebanon* ***Abstract*** *Wide bandgap power switching device technologies earned immense superiority in power density converters in terms of higher switching frequency and efficiency attainments. However, this becomes opposing when utilized in planar pulse transformer-based gate driver applications, where rapid switching speeds originate electromagnetic disturbances due to the passage of common mode currents through the transformer’s stray capacitances. This paper will examine the common mode transient immunity (CMTI) of a shielded pulse planar transformer whilst examining the impact of dielectric material selection on the outcome result. The simulation methodology using Altium Designer and Ansys Q3D Extractor with dynamic links will be presented, in addition to agreeable experimental verifications.*
389830 **11:30**	20’	**Electromagnetic Transient Modeling of Power Electronics in Modelica, Accuracy and Performance Assessment** Alireza Masoom[1], Javad Gholinezhad[1], Tarek Ould-Bachir[2], Jean Mahseredjian[1] *1. Electrical Engineering Department, Polytechnique Montreal, Québec* *2. Computer and Software Engineering Department, Polytechnique Montreal, Québec* ***Abstract*** *This paper presents the Electromagnetic Transient (EMT) modeling and simulation of power electronics in Modelica, a declarative equation-based language. In this paper, modeling of switching components such as diodes, insulated-gate bipolar transistors (IGBT) and multi-level converters using ideal and nonideal components are investigated. A three-phase three-level and a single-phase two-level converter with an open-loop controller are simulated in Modelica and EMTP®. The accuracy and performance of simulations are compared using the variable and fixed-step solvers. Analytical solutions are used for verification of results as well.*
383842 **11:50**	20’	**Transient modeling and simulation of power converter including parasitic elements** Baptiste Trajin[1], Paul-Etienne Vidal[1] 1. *Laboratoire Génie de Production, LGP, Université de Toulouse, INP- ENIT, France* ***Abstract*** *This paper presents a modeling and simulating methodology of transient phenomena in power converters for a large frequency bandwidth. The system under study considers parasitic elements of semiconductor switches, common mode parasitic elements of power transmission lines and their interactions in a high integrated buck converter with one switching cell. In particular, the methodology helps the modeler to chose between several types of models for a given element, i.e. T −model or Π −model of the power transmission lines. The proposed methodology finally allows to obtain a representation well-adapted to the simulation of the behavior of the power converter including parasitic oscillations along time*

TT1- part 2	**Tuesday May 17 (16:50 PM – 18:10 PM) - ROOM 202** **Chairs:** Seiichiro Katsura, Keio University, Yokohama, Japan Matheepot Phattanasak, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand	
389678 **16:50**	20’	**Design and Control of a Synchronous Interleaved Boost Converter based on GaN FETs for PEM Fuel Cell Applications** Elie Togni[1], Fabien Harel[2], Frédéric Gustin[1], Daniel Hissel[1] *1. FEMTO-ST, FCLAB, Univ. Bourgogne Franche-Comté, CNRS, France* *2. Univ. Lyon, Univ. Eiffel, ENTPE, LICIT-ECO7, France* ***Abstract*** *This paper shares some solutions in order to implement a state-of-the-art synchronous Interleaved Boost Converter (IBC), based on gallium nitride (GaN) power transistors. The solutions discussed have been implemented and validated on a synchronous 4-phase IBC (IBC4) prototype operating at a switching frequency of 250 kHz, specially designed to control the electric power delivered by a Proton Exchange Membrane (PEM) fuel cell module to a lithium battery pack. This paper focuses on digital control, such as PWM signal generation and the MCU requirements to reach high switching frequencies. It also discusses the issues related to the propagation delay of the sensors used and how to address them. The high switching frequency enabled by GaN transistors, combined with this DC/DC converter architecture and its phase-shifted control strategy, might heavily strain the load of the single MCU embedded. The real-time management of the different control loops is therefore exposed.*
389606 **17:10**	20’	**Investigating and Modeling the Soft Switching Losses of IGBTs Under Zero Current Switching Conditions** Assil Bouach[1], Sébastien Mariéthoz[1], Arnaud Gaillard[2], Mickaël Hilairet[2] *1. Power Electronics Laboratory, Institute for Energy and Mobility Research, Bern University of Applied Sciences, Switzerland* *2. FEMTO-ST Institute, UTBM, CNRS, Université Bourgogne Franche-Comté, France* ***Abstract*** *The paper presents an investigation of IGBT’s zero current switching (ZCS) losses in a quasi-sinusoidal current mode series resonant converter. Theoretically, losses does not occur when the IGBT is switched at zero current. However, experiments show the opposite and switching losses are not negligible. Manufacturer’s datasheet do not indicate IGBT’s performance under ZCS condition which results in a lack of information to reduce the impact of the converter losses in order to reach high power density. A parametric model for the stored charge evacuated from the IGBT during turn off process is proposed based on experimental results. The impact of the ZCS modulation scheme and the magnetizing inductance of the transformer on zero current switching losses is discussed.*

384962 **17:30**	20’	**Losses prediction in the frequency domain for voltage source inverters.** Hugot Pichon[1], Yves Lembeye[1], Jean-Christophe Crebier[1] *1. G2Elab - Grenoble Electrical Engineering Laboratory, France* ***Abstract*** *This paper introduces a method to estimate the losses produced by high frequency DC/AC and AC/DC converters. This method relies on the frequency dependence of losses combined with a frequency domain description of current waveforms into componant. The approach is based on the characterization of series components, available from manufacturers. The modelling technique in the frequency domain is described then it is applied, based on mathematical fitting, without physical or circuit descritpion relationships. Finally, the validation of the modelling method is carried out on a low voltage VSI*
399122 **17:50**	20’	**Co-simulation domain decomposition algorithm for hybrid EMT-Dynamic Phasor modeling** Hélèna Shourick[1], Damien Tromeur-Dervout[2], Laurent Chédot[1] *1. SuperGrid Institute, France* *2. ICJ, Université de Lyon, UMR5208 CNRS-U Lyon 1, France* ***Abstract*** *An iterative coupling algorithm based on a restricted additive Schwarz domain decomposition is investigated to co-simulate electrical circuits with hybrid electromagnetic (EMT) and transient stability (TS) modeled using dynamic phasors. This co-simulation algorithm does not introduce any delay between the data exchanged at the cosimulation step. The pure linear convergence property of the iterative method allows it to be accelerated towards the true solution by a non-intrusive Aitken’s acceleration of the convergence post-processing, even if the domain decomposition interface conditions make the iterative method divergent. This provides a method less sensitive to the splitting. This algorithm can then be implemented in a distributed master-slaves architecture. An example on a linear RLC circuit combining EMT and TS modeling, and a partitioning with overlap is given.*

TT1. part 3	**Wednesday May 17 (10:30 AM – 12:30 PM) - ROOM 204** **Chairs:** Giovanni Spagnuolo, Università Degli Studi di Salerno, Italy Matthieu Urbain, Université de Lorraine, LEMTA, Nancy, France
385730 **10:30**	20’	**Pre-sizing of a modular high power density DC/DC converter with GaN components** Lucas Pniak[1,2], Bertrand Revol[2], Loïc Quéval[1], Jean-Sylvio Ngoua Teu Magambo[2], Olivier Béthoux[1] *1. Université Paris-Saclay, CentraleSupélec, CNRS, Laboratoire de Génie Electrique et Electrotechnique de Paris, France* *2. Safran Tech, France* ***Abstract*** *This paper presents the modeling and sizing of a multicell DC/DC converter composed of Dual Active Bridge (DAB) converters. The study is based on theoretical results and a pre-sizing algorithm allowing to identify the dimensioning parameters of the structure by maximizing their mass power density. The results of the algorithm show that it can reach 4,5 kW/kg (without EMI filters) which is higher than the realizations presented in the literature.*

385603 **10:50**	20’	**Design and Optimization of a Post-Regulated Inductive Power Transfer System with a Series-Series Compensation** Antonio Vitale[1], Kateryna Stoyka[1], Eugenio Venere[1], Paolo Visconti[2] *1. Medinok S.p.A, Italy* *2. Department of Innovation Engineering, University of Salento, Italy* ***Abstract*** *This paper discusses the design and optimization of a series-series compensated Inductive Power Transfer System (IPTS) followed by a post-regulator consisting in a DC-DC Buck converter. A static model of the system is developed through a first harmonic approximation method, and a procedure for compensation capacitor selection is proposed. A sensitivity analysis of the IPTS performances is carried out with respect to the variations of the primary inverter switching frequency and phase-shift angle, to achieve the efficiency maximization while ensuring the system controllability. Experimental prototype is developed able to deliver up to 29 W output power at a 12 V output voltage, yielding a 91.7% maximum efficiency. The IPTS behavior under both stable and unstable conditions is finally tested, thus confirming the static model predictions.*
385541 **11:10**	20’	**Enhanced Static and Dynamic Modeling of a Series-Series Inductive Power Transfer System with a Buck Post-Regulator** Kateryna Stoyka[1], Antonio Vitale[1], Eugenio Venere[1], Paolo Visconti[2] *1. Medinok S.p.A, Italy* *2. Department of Innovation Engineering, University of Salento, Italy* ***Abstract*** *This paper discusses enhanced static and dynamic modeling of a series-series compensated Inductive Power Transfer System (IPTS) using a Buck converter as a post-regulator. A First Harmonic Approximation (FHA) method is adopted to develop a static model of the analyzed Post-Regulated IPTS (PR-IPTS), highlighting operating regions in which a Buck post-regulator may exhibit controllability issues. Dynamic modeling of the proposed PR-IPTS is then performed by exploiting previous works based on a Coupled-Mode Theory (CMT). Their findings are herein extended to include a phase-shift modulation of the primary full-bridge inverter operating at whatever switching frequency. Experimental tests performed on a laboratory prototype confirm good output voltage regulation capabilities in both static and dynamic load conditions.*
382596 **11:30**	20’	**Three-Phase Bidirectional Active Split Source Inverter for Automotive Traction Application** Antoine Sabrié[1,2], Alexandre Battiston[1], Jean-Yves Gauthier[2], Xuefang Lin-Shi[2] *1. IFP Energies nouvelles –Institut Carnot IFPEN Transport Energie, France* *2. Univ Lyon, INSA Lyon, Université Claude Bernard Lyon 1, Ecole Centrale de Lyon, CNRS Ampère UMR 5005, France* ***Abstract*** *The Split Source Inverter (SSI) is an attractive single-stage boost DC-AC converter topology. Indeed it requires fewer components than the Z-source inverter to realize the boost function and also presents a continuous input current. The main drawback of this topology is its low DC-bus voltage utilization. This paper presents a new derived inverter topology based on the SSI, in order to solve the DC voltage utilization problem and to study its suitability for traction application. Thus, a new three-phase single-stage boost DC-AC inverter topology is derived as well as a possible modulation scheme. The proposed converter and its modulation scheme are simulated in Matlab/Simulink to validate its operation. Finally, it has been validated experimentally on a Proof of Concept (POC).*

399111 **11:50**	20’	**A Virtual Bus Parallel Differential Power Processing Configuration for Photovoltaic Applications** Afshin Nazer[1], Patrizio Manganiello[1], Olindo Isabella[1] *1. Delft University of Technology, Photovoltaic Materials and Devices – ESE, Netherlands* ***Abstract*** *Photovoltaic (PV) systems are often exposed to mismatch caused by partial shading, panels at different tilt angles, dust accumulation, or cell degradation. This paper proposes a novel parallel differential power processing (DPP) configuration to minimize mismatch-related losses. The proposed structure, called PV to Virtual Bus, uses a virtual bus as inputs for DPP converters, so it helps to reduce components' voltage rating. Bidirectional Flyback Converters connected to bridgeless converters being able to generate both positive and negative output voltage – an essential feature for this structure – are used as DPP converters. Perturb and Observe (P&O) algorithm is implemented to find the MPP of each PV string, and a proportional-integral feedback controller is applied to control the Virtual Bus voltage through the central converter. The benefits of the proposed configuration are discussed, and the operation of the proposed structure is further verified through MATLAB/Simulink simulations.*
388953 **12:10**	20’	**A Modified Extended-Boost Active-Switched Quasi Z-Source Inverter** Milad Abbasi[1], Mohammad Mardaneh[1], Ehsan Jamshidpour[2], Soroush Aghili[1] *1. Shiraz university of technology, Iran* *2. GREEN – Université de Lorraine, France* ***Abstract*** *This paper proposes an improved active switched-capacitor topology based on the quasi Z-source inverter (qZSI). Higher boosting capability with lower numbers of components and less voltage stress on switches are the main advantages of the proposed topology. The current source in the proposed structure is continuous and the voltage gain of the inverter is increased compared with other active-switched topologies. The validity of the proposed qZSIs is proved by some simulations.*

TT2. part 1	Tuesday May 17 (15:20 PM – 16:20 PM) - ROOM 204 **Chairs:** Yacine Amara, Université Le Havre Normandie, Le Havre, France Noureddine Takorabet, Université de Lorraine, GREEN, Nancy, France	
389571 **15:20**	20’	**An Overview of High Speed Axial Flux Permanent Magnets Synchronous Machines** Hoda Taha[1], Georges Barakat[1], Yacine Amara[1], Mazen Ghandour[2] *1. Groupe de Recherche en Electrotechnique et Automatique du Havre (GREAH) - Université du Havre - 25, rue Philippe Lebon - B.P. 1123 - 76063 Le Havre cedex, France* *2. Université Libanaise* ***Abstract*** *With the development of axial flux technology and industrial evolution, traditional machines cannot fit application requirements. Radial flux machines represent the majority of machines in the high-speed field but are not always an optimal solution according to the criteria of the considered applications. Designing high-speed axial flux machines remains a challenge where many multi-physics critical issues remain to be solved. This paper reviews high-speed axial flux in terms of different features such as machines types and designing structure, mechanical constraints, specific losses, materials, and application domains. The purpose is to give an overview of different technics and solutions in the literature to meet the needs of the high-speed axial flux machines to investigate their development and integration in different applications.*
388852 **15:40**	20’	**Estimation of Steady-State Torque of Line Start Permanent Magnet Synchronous Motor using Reluctance Network Approach** Hamza Farooq[1], Nicolas Bracikowski[2], Patricio La Delfa[3], Michel Hecquet[1] *1. École Centrale de Lille - Univ. Lille, Arts et Metiers Institute of Technology, Centrale Lille, Junia, ULR 2697 - L2EP, F-59000 Lille, France* *2. IREENA, Université de Nantes, France* *3. Université de Lille - Univ. Lille, Arts et Metiers Institute of Technology, Centrale Lille, Junia, ULR 2697 - L2EP, F-59000 Lille, France* ***Abstract*** *The efficiency of direct-start applications such as pumps or fans can be improved by replacing a squirrel cage induction motor (SCIM) with a line start permanent magnet synchronous motor (LSPMSM). LSPMSM is a super-premium efficiency class IE4 motor, which combines the features of both conventional SCIM and permanent magnet synchronous motor (PMSM). In this paper, a reluctance network approach (RNA) is devised to estimate the maximum steady-state torque of LSPMSM. A reluctance network (RN) in both nonlinear and linear conditions is utilized to investigate the effect of flux-bridge saturation on the computed back electromotive force (EMF). The value of back EMF calculated from RNA is used to calculate the steady-state torque of LSPMSM. Finally, a two-dimensional (2D) finite element method (FEM) simulation is performed to validate the results obtained by the proposed model.*

389626 **16:00**	20’	**Electromagnetic modeling of transformers in EMT-type Software by three circuit-based methods** Sadegh Rahimi Pordanjani[1], Jean Mahseredjian[1], Nicolas Bracikowski[2], Mohammed Naïdjate[2] *1. Department of Electrical Engineering, Polytechnique Montréal, Montreal, Canada* *2. IREENA Laboratory, University of Nantes, France* ***Abstract*** *This paper proposes three circuit-based methods for accurately modelling transformers, with a focus on internal properties such as magnetic flux distribution. In fact, this paper presents a mesh-based model of a transformer by the circuit-based methods and attempts to provide circuit simulators with a model that is as accurate as the finite element method (FEM) in certain respects, such as detailed geometric representation and incorporation of magnetic saturation. Three circuit-based approaches are derived from the Hopkinson analogy, the Buntenbach analogy, and the duality principle. Three circuit-based methods are implemented in an electromagnetic transient (EMT)-type software and validated using a 2D FEM.*

TT2. part 2	**Wednesday May 18 (16:30 PM – 18:10 PM) - ROOM 204** **Chairs:** Georges Barakat, Université Le Havre Normandie, Le Havre, France Farid Meibody-Tabar, Université de Lorraine, LEMTA, Nancy, France	
382297 **16:30**	20’	**Efficiency maps of synchronous machines based on electrical circuits modelling** Haidar Diab[1], Salim Asfirane[1], Yacine Amara[1], Hamid Ben Ahmed[2], Mohamed Gabsi[3] *1. Groupe de Recherche en Electrotechnique et Automatique du Havre (GREAH) - Université du Havre (EA3220) - 25, rue Philippe Lebon - B.P. 1123 - 76063 Le Havre cedex, France* *2. SATIE (Systèmes et Applications des Technologies de l’Information et de l’Energie), UMR CNRS 8029 – ENS Rennes, France* *3. SATIE (Systèmes et Applications des Technologies de l’Information et de l’Energie), UMR CNRS 8029 – ENS Paris-Saclay, France* ***Abstract*** *In many electrical machines applications, as electrical vehicles, the operating conditions are largely varying. Efficiency maps constitute then a convenient way to assess motor designs and their control strategies. This contribution presents the development of a software tool allowing the computation of efficiency maps of synchronous machines. This tool could be applied to all synchronous machines types: wound field, PM, hybrid excited and synchronous reluctance motors.*
381950 **16:50**	20’	**Optimization of material distribution applied to magnet-free rotors of synchronous motors** Célien Bergeron[1], Stephane Vivier[1] *1. Université de Technologie de Compiègne, Roberval (Mechanics, energy and electricity), Centre de recherche Royallieu - CS 60319 - 60203 Compiègne cedex, France* ***Abstract*** *In a relentless desire to continuously improve the performance of electric actuators, topological optimal design methods present interesting possibilities. In particular, this work applies an optimization approach of material distribution in order to define new configurations of material arrangements (air, iron, copper) for internal parts of machines, that potentially provide better performance. This methodology is applied to different design configurations of magnet-free synchronous machine rotors.*

388955 **17:10**	20’	**Quasi 3D Reluctance Network Modeling of an Axial Flux Switched Reluctance Machine** Mostafa Hatoum[1], Salim Asfirane[1], Georges Barakat[1], Yacine Amara[1] *1. Groupe de Recherche en Electrotechnique et Automatique du Havre (GREAH) Université Le Havre Normandie (EA3220), 75 Rue Bellot, 76600 Le Havre, France* ***Abstract*** *This paper studies a 24-pole segmented rotor in a 3-phase, 36-slot per stator topology of an axial-field double stator switched reluctance machine (AFDSSRM) fed with a 3-phase sinusoidal current. It is modeled using a quasi 3D reluctance network which can be considered as an intermediate between multislice and full 3D reluctance network. The main contribution lies in the modeling method by which normal and tangential magnetic flux density as well as electromagnetic torque can be computed in linear and nonlinear permeability conditions, achieving a higher precision/computation time ratio than full 3D finite elements. The paper concludes that quasi 3D reluctance network (Q3DRN) method is a good alternative to full 3D finite elements to obtain main machine performance indicators and offers a solution for machine designers to quickly size an AFDSSRM, and considering the generic nature of the algorithm, this can be extended to other machine types.*
382065 **17:30**	20’	**A starting from zero DC voltage build-up procedure for a magnet-free synchronous reluctance generator in reduced speed operation** Laurent Schuller[1], Jean-Yves Gauthier[1], Romain Delpoux[1], Xavier Brun[1] *1. Laboratoire Ampère (UMR5005) - Institut National des Sciences Appliquées (INSA) – Lyon, France* ***Abstract*** *This paper proposes a parametrized procedure for the voltage build-up of a synchronous reluctance generator connected to a three-phase, two-level controlled rectifier. The magnet-free synchronous reluctance generator is considered in severe conditions where it is neither connected to the grid nor to an electrical energy storage system. Moreover, a reduced speed operation is assumed. The procedure is based on an analysis of the torque generated by the interaction between the residual magnetism and the currents of the generator that maximize the reluctant torque. The choice of the procedure’s parameters that improve the chances of successful voltage build-up are discussed. Experimental verifications are carried out in order to illustrate the analysis.*
390117 **17:50**	20’	**A 3D Nonlinear Magnetic Equivalent Circuit Model for an Axial Field Flux Focusing Magnetic Gear: Comparison of Fixed-Point and Newton-Raphson Methods** Haidar Diab[1], Yacine Amara[1], Georges Barakat[1] *1. Groupe de Recherche en Electrotechnique et Automatique du Havre (GREAH) Université Le Havre Normandie (EA3220), 75 Rue Bellot, 76600 Le Havre, France* ***Abstract*** *An axial field flux focusing magnetic gear is being modeled in this study utilizing a 3D magnetic equivalent circuit technique that takes into consideration the magnetic saturation of the ferromagnetic material. Considering the magnetic saturation of ferromagnetic materials is a critical feature in modeling magnetic gears, particularly those with flux focusing arrangements where specific regions become highly saturated. However, nonlinear modeling comes with its costs, like increased computation time and resource allocation, so it has been always a hot topic for research and development. The approach presented was chosen to be a good lightweight alternative for 3D finite element method modeling that can be used for early design stages. It provided acceptable nonlinear predictions while requiring less time than a 3D finite element method model and saving memory and resources.*

TT3 TECHNICAL TRACKS — SESSION: Control and power management of electrical system

TT3. part 1	Tuesday May 17 (10:30 AM – 12:30 PM) - ROOM 201 **Chairs:** João Pedro Trovão, University of Sherbrooke, e-TESC Lab., Canada Alireza Payman, Le Havre-Normandie University, Le Havre, France	
388448 **10:30**	20’	**Control Strategy for Orbital O2 Tidal System Based on EMR model** Ahmed Al Ameri[2], Alireza Payman[1], Brayima Dakyo[1], Mamadou Baïlo Camara[1] *1. GREAH – Université du Havre - 75 Rue Bellot, 76600 Le Havre, France* *2. Electrical Department, University of Kufa, AL Najaf, Iraq* ***Abstract*** *Recently, electric power production using the tidal turbine system has increased in many countries. Changes in the speed of the marine current pose one of the main challenges in the planning and operation of the electrical network. This paper focuses on the analysis and simulation of Orbital O2 Tidal energy conversion (TEC) system based on Energetic Macroscopic Representation (EMR). The profile of 10 years marine current from the Pentland Firth - Orkney has been used in the EMR model system and the proposed control strategy. The simulation results show the ability of EMR model to adopt the proposed control strategy to maintain the voltage at grid side and to follow the maximum power point tracking (MPPT) at the rotor side of the O2 tidal system.*
380857 **10:50**	20’	**Performance Analysis of a Hardware In the Loop based Emulation of a Naval Propulsion System associated with Supercapacitor Energy Storage System** Nabil Benyahia[1], Jean-Fred Charpentier[1], Franck Scuiller[1], Florent Becker[1] *1. RENAV – Ecole Navale Brest, BCRM Brest – Ecole navale – CC600 - 29240 Brest Cedex 9, France* ***Abstract*** *In this paper, an experimental study of a Hardware In the Loop (HIL) based emulation of a naval propulsion system associated with Supercapacitor energy storage system is proposed. For these purpose two electrical machines are associated in the same shaft (DC machine and PMS machine) to reproduce the behavior of the association of the electrical motor and the propeller of a ship at laboratory scale. The whole system is constituted by three subsystems. The first one is represented by a PM synchronous machine associated with a controlled VSI which plays the role of the electrical propulsion motor following a realistic mission profile. The second one is constituted by a DC machine associated with a DC/DC converter which is controlled in order to reproduce the hydrodynamic behavior of the propeller and the ship, and the third one is constituted by a buck-boost DC/DC converter and an ultracapacitor bank, the ultracapacitor gives to the emulated mechanical shaft the ability to re-inject kinetic power into the grid in case of transient regenerative braking mode. This experimental tool can be associated to innovative hybrid energy system to test and validate hybrid system configuration and can be exploited for many kinds of propellers. In addition, it gives the designer a feedback to optimise ship design. The effectiveness of the proposed HIL platform in terms of DC grid stability and 4 hydrodynamic operation quadrants of propeller is verified by experimental results.*

389230 **11:10**	20’	**Optimal Sizing for Fuel Cell Hybrid Power Sources Under Reliability and Energy Performance Indexes** Toufik Azib[1], Olivier Béthoux[2], Adriano Ceschia[1], Francisco Alves[2] *1. ESTACA’LAB, S2ET Department, École Supérieure des Techniques Aéronautiques et de Construction Automobile (ESTACA)–Paris Saclay, 12 avenue Paul Delouvrier, 78180 Montigny-le-Bretonneux, France* *2. GeePs, Group of Electrical Engineering - Paris, UMR CNRS 8507, CentraleSupélec, Univ. Paris-Sud, Univ. Paris-Saclay, Sorbonne Université, 3 rue Joliot-Curie, 91192 Gif-sur-Yvette, France* ***Abstract*** *This paper presents the development of a sizing approach under reliability and energy performance indexes applied to fuel cell/battery (FC/BAT) hybrid power system. It deals with the interdependence between the components sizing process and the control strategy. The proposed approach is based on imbricated optimization loops and considers two important criteria, fuel consumption and reliability. This proposed approach involves multi-objectives optimisation to study the trade-off between reliability and energy saving to improve the optimal design relevance. Also, the implementation was performed using a low complexity process to offer compromise between computation time and results accuracy. This constitutes a very effective support tools to help design engineers in the early design stages.*
385726 **11:30**	20’	**Voltage unbalance compensation of Flying Capacitor based on a dynamic Pulse Width Modulation applied to a Flying Capacitor leg inverter** Mariem Jday[1], Paul-Etienne Vidal[1] *1. Laboratoire Génie de Production, LGP, Université de Toulouse, INP-ENIT – 47, avenue d’Azereix - BP 1629 - 65016 Tarbes CEDEX, France* ***Abstract*** *This paper introduces a dynamic Pulse Width Modulation scheme, apply to N-level Flying Capacitor inverter. A mathematical approach is detailed to solve the expression of a linear system that model the inverter leg considered. Some degrees of freedom, that have to be set, are exhibited. The proposed technique relies on the relationship made between the degrees of freedom and the voltage unbalance of the floating capacitors. Simulation results are provided to illustrate the performance of such a modulation scheme.*
383065 **11:50**	20’	**Potential operation of battery systems to provide automatic Frequency Reserve Restoration (aFRR) service** Javier Cardo-Miota[1], Emilio Pérez[1], Hector Beltran[1] *1. UJI – Universitat Jaume I, Avinguda de Vicent Sos Baynat, s/n, 12071 Castell´o de la Plana, Comunitat Valenciana, Spain* ***Abstract*** *As a consequence of the enormous growth being experienced by renewable energy systems (RES), conventional technologies such as coal or gas, which unlike RES are dispatchable, are reducing their participation in energy markets, increasing the instability of the electric energy systems. Therefore, there is a need for RES or other converter-based technologies to replace the traditional ancillary service providers. In this sense, battery energy storage systems (BESS) are considered the best candidates. This paper defines a model to simulate the Spanish Automatic Generation Control (AGC). This simulator is used to provide inputs to the operation of a BESS that participates in the secondary frequency regulation market and in the continuous intraday energy market. Subsequently, the paper introduces an economic feasibility study to determine the best BESS size to operate simultaneously in both markets. The results obtained show that BESS with energy capacities of 2 hours are the best option (from both a technical and an economic point of view) to be part of a regulation zone.*

389610 **12:10**	20’	**Photovoltaics at the electric mobility's service: French case study** Khaled Hajar[1], Reza Razi[1], Majid Mehrasa[1], Ahmad Hably[1], Seddik Bacha[2], Antoine Labonne[2] *1. GIPSA-Lab-Université Grenoble Alpes, 11 Rue des Mathématiques, 38400 Saint-Martin-d'Hères, France* *2. G2Elab–Université Grenoble Alpes, 21 Av. des Martyrs, 38000 Grenoble, France* ***Abstract*** *The use of renewable energy sources like solar photovoltaic (PV) to charge electric vehicles (EVs) is an intriguing possibility with various technological and economic benefits. The challenges associated with greenhouse emissions caused by internal combustion engines can be alleviated by combining emission-free EVs with low-carbon PV power generation. For this purpose, this paper provides a case study of a French residential house to maximize the PV power use to charge the EV.*

TT3. part 2	**Wednesday May 18 (10:30 AM – 12:30 PM) - ROOM 202** **Chairs:** Ramon Blasco-Gimenez, Universitat Politécnica de Valéncia, Spain Lotfi Baghli, Université de Lorraine, GREEN, Nancy, France	
389447 **10:30**	20’	**Compliance evaluation of WTG and WPP controllers for self and black start operation** Jaime Martínez-Turégano[1], Salvador Año-Villalba[1], Soledad Bernal-Perez[1], Ramon Blasco-Gimenez[1] *1. Universitat Politècnica de València, Cami de Vera, s/n 46022 València Spain* ***Abstract*** *Adding grid forming capability to theWind Power Plant (WPP) allows it to carry out some functionalities that are usually performed by conventional power generation. Black start operation is one of these functions. It is necessary to assure good performance and observance of all operational and stability requirements to allow WPP to take over this role. This paper presents a compliance evaluation procedure based on a set of defined test cases. Massive simulations have been performed using a computational cluster. Among defined test cases, substations and long cable energisation entail the most challenging steps in the black start operation procedure. Results of the system performance of these cases are presented. All validation has been made through detailed PSCAD/EMTDC simulations.*
385498 **10:50**	20’	**Decoupled Average Model-based Sliding Mode Current Control of LC-filtered Inverters in Rotating Frame** Quang-Manh Hoang[1], Bao-Huy Nguyen[2], Thanh Vo-Duy[1], Minh C. Ta[2], Joao Pedro F. Trovao[3] *1. CTI Lab. for EVs, School of Electrical and Electronic Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam* *2. CTI Lab. for EVs, School of Electrical and Electronic Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam, e-TESC Lab., Université de Sherbrooke, Sherbrooke, QC, J1K 2R1, Canada* *3. e-TESC Lab., Université de Sherbrooke, Sherbrooke, QC, J1K 2R1, Canada* *Polytechnic of Coimbra, IPC-ISEC, DEE, 3030-199 Coimbra, Portugal* *INESC Coimbra, DEEC, University of Coimbra, Polo II, 3030-290 Coimbra, Portugal*

		Abstract *Recently, LC-filtered inverter has been a trendy research object towards the efficient exploitation and use of sustainable energy sources. The nested control scheme of the system includes a voltage control loop and a current one, which can be developed on the rotating d-q frame. The PI controller is employed for the outer loop voltage controller and it performs effectively. However, the PI current controller introduces delay to the system and overshoot occurs frequently due to the influence of nonlinear load. This paper proposes a novel method of decoupled average model-based sliding mode current control performing faster response and better tracking of the desired current. This method is developed on the average model, then fixed-frequency PWM can be used to modulate the inverter. The novel method is compared with a conventional PI controller. The results prove the advantages of the proposed current controller considering limited sampling frequency and critical scenarios with nonlinear load.*
383057 **11:10**	20’	**Neural network model for aggregated photovoltaic generation forecasting** Enrique Belenguer[1], Jorge Segarra[1], Emilio Pérez[1], Juan Redondo[2] *1. Dept. Industrial Systems Engineering and Design - Universitat Jaumi I - Avda. Sos Bayna s/n E-12071, Castell ́o de la Plana, Spain* *2. fenie Energía, C/ Jacinto Benavente 2B E-28232 Las Rozas, Madrid, Spain* ***Abstract*** *This paper presents a forecasting model from 1 to 10 days for the aggregated photovoltaic energy production in Spain. The model uses a convolutional neural network which inputs are meteorological forecasts, historical generation data and the location and installed power of existing plants. The model output is the hourly production of the photovoltaic energy production for the whole system for the following ten days. The results of the model can be used for generation scheduling and system operation on one side and for energy trading in the day-ahead market or in derivative markets on the other side.*
381018 **11:30**	20’	**Real-time simulation of an electric ship in normal and faulty conditions** François Roux[1], Florian Dupriez-Robin[1], Guénaël Le Solliec[1], François Auger[2] *1. CEA TECH de Nantes, 5 rue de l’Halbrane, 44340 Bouguenais, France* *2. Institute of Research in Electrical Energy of Nantes-Atlantique (IREENA), CRTT, 37 Bd de l’Université, BP 406, 44602 Saint-Nazaire Cedex, France* ***Abstract*** *Today’s requirement for improved electrical systems increase needs for accurate, fast and versatile models. MATLABTM/SIMULINK is a good candidate in terms of average simulation for accuracy, versatility and speed, but for detailed simulation (i.e. designed with the SimScape toolbox) it can be very slow, especially when multiple power converters are simulated. This issue can be solved by real time simulators based on FPGAs like OP-5607 from Opal-RT. With these real-time simulators, complex systems can be simulated with a time step of a few hundreds of nanoseconds. This article presents a new methodology in simulation fields which let researchers to interface fast response power electronics converters and slower physicals parts. This new methodology allows designers to evaluate systems at multiple time scales: minutes, seconds and milliseconds. This article emphasizes today’s possibilities of simulating a system as complex as the propulsion line of a cruise ship during an entire 30 min trip. Finally, this kind of simulation allows engineers to increase the accuracy of modeling, even to work on realistic faulty conditions.*

385533 **11:50**	20’	**Electrification of river freight: current status and future trends in Europe** Fabian Amoros[1, 2, 3], Jean-Frédéric Charpentier[1], Walter Lhomme[2], Jean-Yves Billard[1], Benoît Nottellet[3] *1. French Naval Academy Research Institute - BCRM Brest – CC600, 29240, Brest, France* *2.University of Lille1, L2EP (Laboratoire d’Électrotechnique et d’Électronique de Puissance) - 42 Rue Paul Duez, 59800, Lille, France* *3. SEGULA Technologies, 26 Rue Lamartin, 76600, Le Havre, France* ***Abstract*** *As the needs for sustainable freight transport solutions grow, river freight cargo is considered to be a very promising track. Large carriage boats allow up to three times less fuel consumption than trucks per ton.km. How-ever, the use of traditional river freight ships leads to a high level of NOx and PM (particulate matter) emissions. Late evolution in regulation, large lifetime, 60 years for hull and 20 years for engine, as well as economical tightness have slowed down technological improvements. European solutions, such as the use of alternative fuels, electric or hybrid propulsions are studied. Projects with zero emissions are favoured as well as projects with easy potential adaptation into zero emission boat: full-electric vessels and hydrogen powered hybrid ships are the main solutions to be considered. Some new generations of vessels are already launched or planned. This paper aims to expose the challenge and to pre-sent the current status and trends for improving the impact of river freight.*
385244 **12:10**	20’	**Uncertainties Impact and Mitigation with an Adaptive Model-Based Voltage Controller** Muhammad Andy Putratama[1], Rémy Rigo-Mariani[1], Vincent Debusschere[1], Yvon Bésanger[1] *1. Université Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), G2Elab, 38000 Grenoble, France* ***Abstract*** *This paper investigates the impact of three sources of uncertainties on a conventional model-based voltage controller, which are i) model, ii) load/generation forecast and iii) grid impedance/data uncertainties. Due to the common lack of grid data availability at the low voltage level, a specific attention is attached to the mitigation of grid impedance uncertainties by proposing a convex optimization-problem based on local measurements to tune the controller parameters. Furthermore, a voltage performance index (VPI) is introduced to measure the efficiency of the proposed adaptive controller. The proposed simulations highlight how different types and levels of uncertainties can impact the controller performances. Furthermore, the proposed mitigation strategy shows a significant improvement on the controller performance in terms of voltage profiles. The studies are tested on 11-bus radial distribution system.*

TT3. part 3	**Wednesday May 18 (16:30 PM – 18:10 PM) - ROOM 202** **Chairs:** Pr Camara Mamadou Baïlo, Université Le Havre Normandie, France Jean-Philippe Martin, Université de Lorraine, LEMTA, Nancy, France	
387948 **16:30**	20’	**An Improved Maximum Power Point Tracking for Photovoltaic Distributed Energy System associated with a Shunt Active Power Filter** Rosalie Rouphael[1], Ahmad Ghamrawi[1], Nezha Maamri[1], Jean-Paul Gaubert[1] *1. Université de Poitiers, Laboratoire d’Informatique et d’Automatique pour les Systèmes LIAS - 2 rue Pierre Brousse, 86000 Poitiers, France* ***Abstract*** *Nowadays, an important interest in decentralized energy production in multi-sources systems is taking place in everyday life generally and in electrical power engineering domain particularly. In this paper, the optimal architecture proposed with two stages includes a PV source generator connected to the electrical grid through two level converters: a DC/DC converter and a DC/AC converter. The microgrid formed also feeds a non-linear load polluting the network harmonically along with the converters. The dimension study and control proposed in this paper ensure the global correct functioning of the system. First, the quadratic boost converter is controlled using a novel MPPT algorithm based on adaptive P&O that proved its superiority to the latter in rapid changing climatic conditions. Then, a shunt active power filter (SAPF) is employed with a direct power control (DPC) technique guaranteeing the rejection of harmonic currents and the transfer of the active power to the electrical network. The results presented proved with high efficiency and great robustness, in Simulink/Matlab™ environment, the ability of the global system to inject the active power of the PV generator to the grid, to contribute in improving the quality of electrical energy at the connection point and to adapt correctly to load variation.*
389191 **16:50**	20’	**Passivity based control of two distributed generations in DC microgrid** Roghayeh Gavagsaz-Ghoachani[1], Matheepot Phattanasak[2], Jean-Philippe Martin[3], Serge Pierfederici[3] *1. Department of Renewable Energies Engineering, Faculty of Mechanical and Energy, Shahid Beheshti University, Tehran 1983969411, Iran* *2. Department of Teacher Training in Electrical Engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok 10800, Thailand* *3. LEMTA – Université de Lorraine, 54505 Vandoeuvre-lès-Nancy, France* ***Abstract*** *This paper proposed a new decentralized control method for two different power rated energy sources equipped with DC-DC switching power converter formed as distributed generations (DG) supply DC microgrid. If each DG has passivity property, one can apply this control for all DGs. The model of the considered system is presented using a well-known port Hamiltonian matrix. Thereby with an interconnection and damping assignment passivity-based control (IDA PBC) global stability is guaranteed. Moreover, applying droop voltage control to change the state variable references allows for the current sharing between the two DG To validate the proposed method, simulation results are provided*

387344 **17:10**	20’	**Adaptive Hamiltonian Energy Control with Built-in Integral Term for Fuel Cell Hybrid Power Conversion System** Shengzhao Pang[1], Milad Bahrami[2], Jean-Philippe Martin[2], Yigeng Huangfu[1], Serge Pierfederici[2] *1. Northwestern Polytechnical University, 710072, Xi'an, Shaanxi, China* *2. LEMTA – Université de Lorraine, 54505 Vandoeuvre-lès-Nancy, France* ***Abstract*** *In this paper, an adaptive Hamiltonian energy control strategy is presented for the proposed power electronics architecture of the fuel cell hybrid application. The proposed controller with added integrator action is based on the Hamiltonian–Lyapunov function. In contrast to previous work, the proposed control approach aims to control the fuel cell output current and has an integrator built into the control system to eliminate steady-state errors. A Lyapunov candidate function is selected to demonstrate the large-signal stability of this system. The efficacy and robustness of the designed control approach are authenticated by experimental results.*
384908 **17:30**	20’	**Photovoltaic module series resistance identification at its maximum power production** Kari Lappalainen[1], Michel Piliougine[2], Seppo Valkealahti[1], Giovanni Spagnuolo[2] *1. Tampere University, 33720 Tampere, Finland* *2. University of Salerno, 84084 Salerno, Italy* ***Abstract*** *Analysis of measured current–voltage (I–V) curves provides a cost-effective solution for online condition monitoring of photovoltaic (PV) modules. The I–V curves of PV modules can be modelled accurately using the well-known electrical single-diode model. In practical applications, condition monitoring should be based on measurements performed near the maximum power point (MPP) by affecting PV power production negligibly. This paper proposes a novel method for determination of the series resistance from measurements performed near the MPP. The proposed method is experimentally validated using I–V curves of two PV modules measured in Malaga, Spain. The results show that the series resistance can be accurately determined from measurements performed near the MPP. Especially the results obtained with an ISOFOTON ISF-145 PV module are very promising: the scaled series resistances obtained from measurements done without lowering the PV power more than 5% of the maximum power differ on the average by no more than 2% of the series resistances obtained from the whole I–V curves.*
388640 **17:50**	20’	**A simplified model of flexible power point tracking algorithms in double-stage photovoltaic systems** Candelaria Utrilla[1], Hossein Dehghani Tafti[2], Anusha Kumaresan[3], Jérôme Buire[1], Vincent Debusschere[1], Josep Pou[4], Nouredine Hadjsaïd[1, 5] *1. Université Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), G2Elab, 38000 Grenoble, France* *2. Department of Electrical, Electronic and Computer Engineering, University of Western Australia, Crawley WA 6009, Australia* *3. Energy Research Institute at NTU (ERI@N), Interdisciplinary Graduate Programme, Nanyang Technological University, Singapore 639798, Singapore* *4. School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore 639798, Singapore* *5. Nanyang Technological University, Singapore 639798, Singapore*

		Abstract *Traditionally, photovoltaic (PV) systems have been operated using maximum power point tracking algorithms, which force the PV arrays to produce the maximum available power at all times. Nevertheless, distribution system operators are increasingly asking for flexible power point tracking (FPPT) algorithms, which allow to regulate the PV power to a predefined reference value. FPPTs, however, are difficult to tune and often have a non-linear behavior, which complicates the modeling of PV systems for power system stability studies. This paper proposes a simplified model that reproduces the dc-side dynamics of a double-stage FPPT controlled PV system. In addition to its simple tuning, the key advantage of the proposed model is that it can be easily translated into differential equations, which can be used in small-signal stability analyses.*

TT3. part 4	**Thursday May 19 (10:30 AM – 12:30 AM) - ROOM 204** **Chairs:** Ehsan Jamshidpour, Université de Lorraine, GREEN, Nancy, France Thierry Boileau, Université de Lorraine, LEMTA, Nancy, France	
388136 **10:30**	20’	**A systematic design methodology for a single phase transfer delay based PLL operating under distorted grid voltages** Meriem Merai[1], Mohamed Wissem Naouar[1], Ahmad Ammar Naassani[2], Eric Monmasson[3] *1. Université de Tunis El Manar, Ecole Nationale d'Ingénieurs de Tunis, LR11ES15 Laboratoire des Systèmes Electriques, 1002, Tunis, Tunisia* *2. Department of Electrical Drives, Faculty of Electrical and Electronic Engineering, University of Aleppo, Syria* *3. SATIE-IUP GEII, rue d'Eragny, 95031 Cergy Pontoise, France* ***Abstract*** *Standard Transfer Delay based Phase-Locked Loop (TD-PLL) is a simple and popular grid synchronization method used for the control of single-phase Grid connected Converters (GcCs). The main drawback of the TD-PLL is that it is affected by the harmonics of the line voltage, which lead to a double-line frequency error in the estimated grid voltage phase. To tackle this problem, this paper presents a systematic TDPLL design methodology that allows cancellation of the double-line frequency in the estimated grid voltage phase, even when the measured grid voltage is highly distorted. Numerous results were presented and discussed to show the effectiveness of the proposed design methodology.*
388485 **10:50**	20’	**Fully decentralized control strategy for synchronous open-winding motors** Louis Dassonville[1,2], Xuefang Lin-Shi[1], Jean-Yves Gauthier[1], Ali Makki[2] *1. Univ. Lyon, INSA Lyon, CNRS, Ampère, UMR 5005, 69621 Villeurbanne, France* *2. Keep’Motion, 8200 Luzinay, France* ***Abstract*** *This paper proposes a decentralized control strategy for multiphase open-winding permanent magnet synchronous motors (OW-PMSMs). The main goal is to achieve high levels of fault tolerance on the control part. Indeed, multiphase motors are well known for their fault tolerance and reliability, but a centralized control loses this advantage in case of control system fault. This work tries to reduce dependencies between each winding of an OW-PMSM by proposing a decentralized control strategy where each motor winding has its own control system. To obtain desired torque, each winding current must track a sinusoidal current reference. A flatness-based control is used to improve the tracking dynamics. Simulations on a three-phase OW-PMSM are performed in health and fault conditions. Results validate the proposed decentralized control strategy and show a high availability of the controlled OW-PMSM drive.*

385676 **11:10**	20’	**Average Model-based Sliding Mode Control Schemes of Bidirectional Boost DC-DC Converters** Hai-Nam Nguyen[1], Bao-Huy Nguyen[2], Thanh Vo-Duy[1], Minh C. Ta[2], Joao Pedro F. Trovao[3] 1. *CTI Lab. for EVs, School of Electrical and Electronic Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam* *2. CTI Lab. for EVs, School of Electrical and Electronic Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam & e-TESC Lab., Université de Sherbrooke, Sherbrooke, QC, J1K 2R1, Canada* *3. e-TESC Lab., Université de Sherbrooke, Sherbrooke, QC, J1K 2R1, Canada* *Polytechnic of Coimbra, IPC-ISEC, DEE, 3030-199 Coimbra, Portugal* *INESC Coimbra, DEEC, University of Coimbra, Polo II, 3030-290 Coimbra, Portugal* ***Abstract*** *The nonlinearity of boost DC/DC converters is well-known in the field of power electronics control. Traditionally, the converter model can be linearized at an operating point which is the small-signal linearization. On the other hand, the converter can be regulated by using nonlinear controllers in which sliding mode control (SMC) method is commonly applied. The previous works of SMC were often based on the switching model of converter which suffer from non-uniform switching frequency and/or chattering. This paper proposes two novel average model-based SMC schemes for bidirectional boost DC/DC converters; one is a single-stage controller and the other one is a cascade control loop. The new controllers outperform the traditional ones in terms of response time and accuracy that is validated by critical simulation scenarios. The proposed approach can be extended to other complex power electronics converters.*
389494 **11:30**	20’	**Electrical and thermal modelling of PEMFCs for naval applications** Ayoub Igourzal[1, 2], François Auger[2], Jean-Christophe Olivier[2], Guénaël Le Solliec[1] *1. CEA Tech – Nantes, Technocampus Ocean, 5 Rue de l’Halbrane, 44 340 Bourguenais, France* *2 : Institut de Recherche en Énergie Electrique de Nantes-Atlantique (IREENA)* *IREENA-CRTT, 37 Boulevard de l’Université, BP 406, 44 602 Saint Nazaire Cedex, France* ***Abstract*** *This paper presents a semi-empirical model of Proton Exchange Membrane Fuel Cell (PEMFC), combining electrical and thermal phenomena and system degradations. The originality of our approach is the link between activation and diffusion phenomena by using a semi-empirical equation to create a new fast and accurate PEMFC model. Then, a degradation model is defined and adapted to energy management needs. The aim of this design is to study fault tolerant multi stack Fuel Cell (FC) systems, to study their interactions with converters and to design optimal control and adaptative management rules. The degradation model is used to adapt management laws according to the state of health of each stack. This work also offers an exhaustive analysis of the existing models available in the literature including a set of models compatible with the needs of Modular Fuel Cells (MFC) studies.*

389280 **11:50**	20’	**An Improved Control of High Efficiency Series Converter for Fuel cell/Supercapacitor Hybrid System** Apinya Siangsanoh[1,2], Wattana Kaewmanee[1], Roghayeh Gavagsaz Ghoachani[3], Jean-Philippe Martin[2], Mathieu Weber[2], Matheepot Phattanasak[1], Serge Pierfederici[2], Gaël Maranzana[2], Sophie Didierjean[2] *1. TE-KMUTNB, Bangkok 10800, Thailand* *2. LEMTA – Université de Lorraine, 54505 Vandoeuvre-lès-Nancy, France* *3. Department of Renewable Energies Engineering, Faculty of Mechanical and Energy, Shahid Beheshti University, Tehran 1983969411, Iran* ***Abstract*** *This paper presents improved control law of a hybrid system using a series converter connected between fuel cell and supercapacitor. The presented topology provides proper utilization of SC and achieves high efficiency in a steady state. In normal operating mode, the reference voltage of the supercapacitor is defined by the proposed controller so that the voltage across series converter reaches zero in a steady-state. Simulation and experimental results for a given load profile are presented in this paper to validate the proposed improved control law.*
389348 **12:10**	20’	**Nine-phase machines with symmetrical and asymmetrical star winding configurations: comparison for detection of incipient faults** Anthony El Hajj[1, 2], Eric Semail[1], Abdelmounaïm Tounzi[1], Darius Vizireanu[2], Jalal Cheaytani[2] *1. Univ. Lille, Arts et Metiers Institute of Technology HESAM Université, Centrale Lille, Junia, ULR 2697 - L2EP, 59000 Lille, France* *2. EDF R&D, 91120 Palaiseau, France* ***Abstract*** *Two approaches are commonly used for modelling and control of nine-phase fault-tolerant machines with symmetrical and asymmetrical star winding configurations: The Vector Space Decomposition (VSD) and the decentralized d-q modelling. In this paper, it will be shown how the VSD approach used for machines with an asymmetrical star winding configuration, unlike the decentralized d-q one used for machines with a symmetrical star winding configuration, can be helpful for non-intrusive Fault Detection and Diagnosis (FDD) purposes. Supporting MATLAB/Simulink simulations are discussed.*

TT4 **TECHNICAL TRACK** **SESSION: Microgrids/smart grids**

TT4. part 1	Tuesday May 17 (10:30 AM – 12:30 PM) - ROOM 204 **Chairs:** Bruno Sareni, University of Toulouse, CNRS, Toulouse INP, France Azeddine Houari, Nantes Université, IREENA, Saint-Nazaire, France	
385568 **10:30**	20’	**Storage management optimization based on electrical consumption and production forecast in a photovoltaic system** Anthony Aouad[1], Khaled Almaksour[1], Dhaker Abbes[1] *1. Univ. Lille, Arts et Metiers Institute of Technology, Centrale Lille, Junia, ULR 2697 - L2EP, 59000 Lille, France* ***Abstract*** *This paper presents a storage management method, which aims to minimize the economic or ecological cost of a grid connected PV system or to find the best compromise between the two, in different tariff scenarios while respecting a full self-consumption constraint imposed by the DSO. The control is based on electrical consumption, production, and CO_2 forecasts developed using feedforward neural network models based on data from a real-scale smart-grid demonstrator at the Catholic university of Lille, France. The results provide a comparison of the economic and ecological gains for the three proposed strategies. Best compromise is achieved when considering off-peak tariff option.*
382097 **10:50**	20’	**Residential DC Microgrid Bus Voltage Control based on Two-phase Interleaved Boost Converter** Manel Jebali Ben Ghorbal[1], Jihen Arbi Ziani[1,2] *1. Université de Tunis El Manar, Ecole Nationale d'Ingénieurs de Tunis, LR11ES15 Laboratoire de Systèmes Electriques, 1002, Tunis, Tunisie* *2. Université de Carthage, Institut Supérieur de Sciences Appliquées et de Technologie de Mateur, 7030, Mateur, Tunisie* ***Abstract*** *This paper presents a DC microgrid DC bus voltage regulation based on two-phase Interleaved Boost Converter (IBC). Two cascaded loops using PI controllers are implemented in order to regulate the input inductor currents for each DG source converter and the common DC bus voltage set to 120V and feeding resistive loads and Constant Power Loads (CPL). Simulation results using PSIM software as well as experimental results are given to show the implemented control algorithm.*
386740 **11:10**	20’	**Behavioural modelling of multi-MW hybrid PV / Diesel modular power plant** Sani Moussa Kadri[1,2], Brayima Dakyo[1], Mamadou Baïlo Camara[1], Moussa Yrébégnan Soro[2] *1. GREAH – Université Le Havre, Normandie, 25 Rue Philippe Lebon, 76600 Le Havre, France* *2. Institut International d'ingénierie de l'Eau et de l'Environnement (2iE), rue de la Science, BP 594 Ouagadougou 01, Burkina Faso* ***Abstract*** *This paper deals with the behavioural modelling of a multi-MW PV/Diesel hybrid power plant based on long term monitoring over years. The approach is based on the analysis of production data correlated with solar resources and fuel consumption. The links between PV power and irradiance at different points of energy conversion chain up to the AC point of common coupling are carried out. The adopted methodology is to proceed to a formulation of the behavioural model of PV production considering trends and statistics observations. The first step was data classification targeting causalities and consequences of main disturbances. The second step validates the established models with operating data. The aim is to provide relevant set for scenarios simulation that allows optimal design and energy management for such hybrid plant.*

389495 **11:30**	20’	**Small signal stability study for island distributed generation system controlled by IDA-PBC-IA and power decoupled droop control** Nidhal Khefifi[1], Azeddine Houari[1], Mohamed Machmoum[1], Malek Ghanes[2], Mehdi Zadeh[3] *1. Institut de Recherche sur l’Énergie Electrique de Nantes-Atlantique (IREENA) – University of Nantes, 44600 Saint Nazaire, France* *2. LS2N, Ecole Centrale de Nantes, Nantes, France* *3. Department of Marine Technology, Faculty of Engineering, Marinteknisk senter, D2.262, Tyholt, Norway* ***Abstract*** *The supply of electricity to remote areas such as islands or rural areas presents many challenges. To reduce costs, the use of renewable energy resources is recommended. In these circumstances, it is always important to improve the power quality in terms of waveform and power sharing between different distributed generators. In this paper, we focus on the power sharing between different distributed generators, and for this purpose, an improved decoupled control, proposed in our previous work, is studied to prove its effectiveness in providing wide range of stability. The internal control has been assimilated to a second-order filter and then, the improved decoupled control is studied to prove its effectiveness to ensure a wide range of stability. For this purpose, a microgrid composed of two distributed generators is studied. Its small-signal model including the distributed generators, the loads and the droop control laws that ensure the interconnection between the generators is revealed. A stability study in the sense of the indirect Lyapunov theory based on the evaluation of the eigenvalues of the system is performed to show the "local stability" in presence of different types of loads, the impact of the system and the control parameters on the eigenvalue is studied using the modal analysis technique. The validation of these results is proven by simulation.*
389034 **11:50**	20’	**Modelling and Optimization of Power Allocation and Benefit Sharing in a Local Energy Community** Alyssa-Diva Mustika[1, 2], Rémy Rigo-Mariani[1], Vincent Debusschere[1], Amaury Pachurka[2] *1. Université Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), G2Elab, 38000 Grenoble, France* *2. Beoga, Montpellier, France* ***Abstract*** *This paper proposes a strategy for the resources management and power allocation in an energy community. Especially, the fairness of the benefit sharing is assessed thanks to a metric introduced as a monthly net energy price (in c€/kWh) from the viewpoint of each individual and computed as the individual bill over the consumed energy. The community management decouples the operational (i.e., power dispatch) from the settlement phase (i.e., monthly community billing). In particular, the investigated billing approach is based on an optimization process with an additional constraint to limit the gap between the maximum and minimum identified prices over all the community members. This study then provides a new method to better address individual’s need in the community. The results show a narrow range of the individual energy price and 11.5% collective bill reduction compared to a case where the members act individually.*

382165 **12:10**	20’	**A Distributed Secondary Control for Autonomous AC Microgrid based on Photovoltaic and Energy Storage Systems** Sidlawendé Ouoba[1], Azeddine Houari[1], Mohamed Machmoum[1] *1. Institut de Recherche sur l’Énergie Electrique de Nantes-Atlantique (IREENA) – University of Nantes, 44600 Saint Nazaire, France* ***Abstract*** *In this paper, a distributed control is proposed for Distributed Energy Storage Systems (DESSs) and Renewable Energy Sources (RESs) power management in islanded Microgrid (MG). The power management strategy is designed to maintain generation/consumption balance, to ensure State of Charge (SoC) balancing of the DESSs and MG frequency/voltage (f & V) regulation. A fully distributed control without leader-follower strategy is used to manage the power flow between renewable generators, energy storage and consumption (critical and non-critical loads), to balance the SoC of the DESSs and to restore the frequency and voltage to their nominal value only thanks to low bandwidth communication. The strategy framework of the power management set the islanded MG in 04 operations modes (normal mode, PV active power curtailment mode and load shedding and reconnection mode) in order to provide a high quality and reliable power source in the islanded MG. A MATLAB/Simulink simulation is performed with a system of two Batteries Energy Storage Systems (BESSs), three loads (a critical/variable load and two non-critical/constant loads) and photovoltaic (PV) generator, in order to verify the effectiveness and the resilience of the proposed power management method in several operation modes.*

TT4. part 2	**Tuesday May 17 (16:50 PM – 18:10 PM) - ROOM 204** **Chairs:** Thierry Boileau, Université de Lorraine, LEMTA, Nancy, France Babak Nahid-Mobarakeh, McMaster University, Canada	
389593 **16:50**	20’	**MANA-Based Load-Flow Solution for Bipolar DC Microgrids** Nasim Rashidirad[1], Jean Mahseredjian[1], Ilhan Kocar[1] *1. Polytechnique Montreal, Montreal, QC H3T 1J4, Canada* ***Abstract*** *In this paper, a novel load-flow method for unbalanced bipolar dc microgrids (BDCMGs) is presented. The principles of this method are based on the modified augmented nodal analysis (MANA) formulation, which is generic and simple to formulate. An unbalanced BDCMG is also used to verify the validity of the proposed MANAbased formulation. The findings also substantiate that in BDCMGs, different connections of DGs can highly affect the bipolar voltage profiles, in presence of different line resistances and droop coefficients.*
389725 **17:10**	20’	**A Dynamic Real-Time Optimization Algorithm for the Revenue Assessment of a Vehicle-To-Grid System in Presence of Wear Cost Model** Majid Mehrasa[1], Reza Razi[2], Mehrdad Gholami[1], Khaled Hajar[2], Antoine Labonne[1], Ahmad Hably[2], Seddik Bacha[1] *1. Laboratoire de Génie Electrique de Grenoble (G2ELab) - Université Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), 21 Av. des Martyrs, 38000 Grenoble, France* *2. GIPSA-Lab - Université Grenoble Alpes, 11 Rue des Mathématiques, 38400 Saint-Martin-d'Hères*

		Abstract *This paper presents a linear programming optimization algorithm with changeable weighting factors for reaching maximum revenue in the peak-value duration of the PV power and electricity price in a smart Vehicle-to-Grid (V2G) system. In order to render an accurate revenue assessment, the EV battery wear model is also taken into consideration through the parameters including the equivalent daily discount, estimated cycle life, the battery capital cost and battery salvation value. Moreover, a linear objective function is proposed by exerting the forecasted PV power profile to constitute the dynamic weighting factors for the EV battery power variables. The comparative simulation results in MATLAB/Simulink verify that the proposed dynamic optimization algorithm can reach its maximum revenue in three times i.e., the peak-value duration of the PV power, the peak-value duration of electricity price and the end of the simulation. In addition, the results affected by the EV battery wear model are presented.*
387845 **17:30**	20’	**Generation of energy demand and PV production profiles based on Markov chains for the design and operation of microgrids** Hugo Radet[1], Bruno Sareni[1], Xavier Roboam[1] *1. Laboratoire Plasma et Conversion d'Energie, CNRS (UMR5213), Université Paul Sabatier - Toulouse III, Institut National Polytechnique de Toulouse – INPT, Toulouse, France* ***Abstract*** *This work provides a simple and straightforward method based on Markov chains to generate a large number of probabilistic energy production and demand profiles when historical measurements are available. The method is intended for energy modelers seeking a simple generation approach to test different design and operation methods for microgrids without spending too much time in this generation phase. Results show that the proposed method can capture the main statistical features and the temporal variability of real data at both long and short time scales, despite the method’s simplicity.*
385567 **17:50**	20’	**Consensus-based distributed primary control for accurate power sharing in islanded mesh microgrids** Youssef Hennane[1, 2], Abdelmajid Berdai[2], Jean-Philippe Martin[1], Serge Pierfederici[1], Farid Meibody-Tabar[1] *1. Laboratoire Énergies et Mécanique Théorique et Appliquée (LEMTA)* *Université de Lorraine, Centre National de la Recherche Scientifique (UMR7563 / URA875), 54505 Vandoeuvre-lès-Nancy, France* *2. Energy and Electrical Systems Laboratory National School of Electricity and Mechanics, ENSEM, University Hassan II of Casablanca, Casablanca, Maroc* ***Abstract*** *In this paper, a consensus-based distributed control strategy for mesh microgrids based on droop control approaches is proposed. The proposed control is based on a communication among local controllers capable of exchanging informations with the neighbouring distributed generators (DGs) through local low-speed communication network. It allows the DGs’ active and reactive power sharing in islanded mesh reconfigurable microgrids. The efficiency of the proposed control strategy is validated based on the simulation results obtained from Simulink/Simscape of matlab and the experimental ones using Hardware-in-the-Loop (HIL) real time simulator of opal-rt and dSPACE platforms. The robustness of the proposed control is also investigated with respect to loads’ variation, microgrid topology changes and communication time delays. Also, the effect of the proposed primary control on voltage and frequency deviation is investigated*

TT4. part 3	**Wednesday May 18 (10:30 AM – 12:30 PM) - ROOM 201** **Chairs:** Maria Carmela Di Piazza, National Research Council, Institute of Marine Engineering, Italy Ehsan Jamshidpour, Université de Lorraine, GREEN, Nancy, France	
389752 **10:30**	20’	**Analysis and Assessment of a Commercial Microgrid Laboratory Platform** Mariem Dellaly[1], Sonia Moussa[1], Sondes Skander-Mustapha[2], Ilhem Slama-Belkhodja[1] *1. Université de Tunis El Manar, Ecole Nationale d'Ingénieurs de Tunis, LR11ES15 Laboratoire de Systèmes Electriques, 1002, Tunis, Tunisie* *2. Université de Carthage, Ecole Nationale d'Architecture et d'Urbanisme, Laboratoire de Systèmes Electriques, 1002, Tunis, Tunisie* ***Abstract*** *The growth of residential rooftop solar PV has given rise to new operating concepts such as collective solar self-consumption where several prosumers come together to form a microgrid with its distributed PV generations, its storage systems, its local loads with an energy management system (EMS) to optimize the operation modes according to desired criteria. Such microgrid working is relatively complex and adapting the EMS of a commercial microgrid to meet national standards and regulations or to perform deep investigations requires first analysis and assessments. This paper deals with a commercial microgrid laboratory platform. Tests and data analysis are performed to establish the flowchart of its central EMS, and then, in a future work, to develop an accurate model of the platform to test new investigated EMS.*
389658 **10:50** **Remote presentation**	20’	**Enhanced performances of the DFIG power control using the exponential reaching law based sliding mode control** Zouheyr Dekali[1], Lotfi Baghli[2], Abdelmadjid Boumediene[1] *1. Laboratoire D'Automatique de Tlemcen, Université de Tlemcen, 13000 Tlemcen, Algeria* *2. Université de Lorraine, GREEN, EA 4366, 54500 Vandœuvre Les-Nancy, France* ***Abstract*** *This paper describes the design and the application of the exponential reaching law based first order sliding mode control. The proposed algorithm is applied to a two-levels back-to-back inverter used in the DFIG wind power conversion system topology. This study mainly aims to test the performance of this nonlinear controller and its effects on the chattering phenomenon. The approach is applied on both rotor side converter and grid side converter in order to control the DFIG stator power and power flow between the rotor and the power grid respectively. The simulation results for 2 MW DFIG are evaluated to demonstrate the effectiveness of the proposed control technique.*
388885 **11:10**	20’	**An ADMM-based Coordination Strategy for the Control of Distributed Storage at the Household Level – Impact of the End-User Settings** Rémy Rigo-Mariani[1], Vincent Debusschere[1] *1. Université Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), Laboratoire de Génie Electrique de Grenoble (G2ELab) - 21 Av. des Martyrs, 38000 Grenoble, France* ***Abstract*** *This paper focuses on a coordination strategy to manage distributed storage systems located at the end-user level. The implemented method lies on a consensus Alternating Direction Method of Multipliers adapted to a decentralized problem in which the followers and leaders exchange prices (Lagrangian) and quantities information over the iterations. A specific attention is attached to the end-users’ objective function and their willingness to respond to the coordinator signals. A layout of up to 100 households is simulated with the performances assessed regarding the trade-off between end-users’ loss of revenue and global objective improvements.*

389607 **11:30**	20’	**Loadability Assessment of Droop-Controlled Islanded Microgrids: Integration of Droop Control Functions under Unbalanced Loading** Nasim Rashidirad[1], Jean Mahseredjian[1], Ilhan Kocar[1], Seyed Masoud Mohseni-Bonab[2], Omar Saad[2] *1. Polytechnique Montréal, Montreal, QC H3T 1J4, Canada* *2. Hydro-Quebec/IREQ, Varennes, QC J3X 1S1, Canada* ***Abstract*** *One key factor in the operation of droop-controlled islanded microgrid (IMG) systems is its maximum loadability. In this paper, the effect of droop controllers on loadability of IMGs is studied. Moreover, the effect of different unbalanced conditions, droop functions, and reactive droop coefficients on the IMG loadability are taken into account. The proposed model is examined on an unbalanced 38-bus ac IMG. The findings substantiate that reactive droop function (Q-droop), due to its intentional voltage deviation, highly affects the IMG loadability, while active droop function (P-droop) does not have any effect.*
389562 **11:50**	20’	**Modeling and Experimental Validation of a Voltage-Controlled Split-pi Converter Interfacing a High-Voltage ESS with a DC Microgrid** Massimiliano Luna[1], Antonino Sferlazza[2], Angelo Accetta[1], Maria Carmela Di Piazza[1], Giuseppe La Tona[1], Marcello Pucci[1] *1. INM - Consiglio Nazionale delle Ricerche (CNR), Via U. La Malfa, 153, 90146 Palermo, Italy* *2. Dip. di Ingegneria - Università degli Studi di Palermo (UNIPA)* *Viale delle Scienze, Ed. 10, 90128, Palermo, Italy* ***Abstract****. The Split-pi converter is a suitable choice to interface an electrical storage system (ESS) with a DC microgrid. Usually, the ESS voltage is lower than the grid-side voltage. However, due to current limits, the use of a high-voltage ESS is unavoidable when high power levels are required. In such cases, the ESS voltage can be higher than the microgrid voltage, especially with low microgrid voltages such as 48 V. The present work aims at modeling the Split-pi converter operating with an ESS voltage higher than the grid-side voltage in three typical microgrid scenarios in which the controlled variable is the converter’s output voltage. The devised state-space model considers the parasitic elements and the correct load model for each scenario. It is shown that the presence of the input LC filter can make the design of the controllers more complicated with respect to those of a Split-pi operating with ESS voltage lower than grid-side voltage. Simulations and experimental tests on a lab prototype validated the study.*
388763 **12:10**	20’	**Simulation and Operation Analysis of a Smart Grid using Simulink** Alexander Van Waeyenberge [1], Bruno Canizes[1], Joao Soares[1], Sergio Ramos[1], Simon Ravyts[2], Juliana Chaves[1], Zita Vale[3] *1. GECAD Research Center, Polytechnic of Porto, R. Dr. Antonio Bernardino de Almeida 431, 4200-072 Porto, Portugal* *2. ESAT, ELECTA, KU Leuven, Ghent, Belgium* *3. Polytechnic of Porto, R. Dr. Antonio Bernardino de Almeida 431, 4200-072 Porto, Portugal* ***Abstract*** *Changes will be required to handle the increased power flow in the network as the distribution infrastructure ages and the number of EVs and renewable grows. Designing and operating an intelligent network that reacts to changing power flows to ensure the optimal operation is the most economical option than fortifying the network with heavier cables. This work aims to build a model of a 13 bus medium voltage distribution network with high penetration of distributed energy resources and use it to analyze network conditions. The MATLAB Simulink software is used to model and evaluate the network. The outcomes suggest the model is promising and valid even when renewable generation is at low levels.*

SS2 **SPECIAL SESSION** **SESSION: Reliability and Safety management of Power Systems**

SS2	Tuesday May 17 (15:20 AM – 16:20 PM) - ROOM 201 **Chairs:** Afef Bennani Ben Abdelghani, University of Carthage/University of Tunis El Manar, INSAT/ENIT, Tunisia Frédéric Richardeau, University of Toulouse, CNRS, Toulouse INP, France	
388621 **15:20**	20’	**A Hybrid Fourier and Wavelet-based Method for the Real-time Detection and Characterization of Subsynchronous Oscillations** Keijo Jacobs[1], Reza Pourramezan[1], Younes Seyedi[1], Houshang Karimi[1], Jean Mahseredjian[1] *1. Polytechnique Montréal, 2500 Chem. de Polytechnique, Montréal, QC H3T1J4, Canada* ***Abstract*** *Modern electric power systems are becoming more complex due to the proliferation of distributed energy resources (DERs) and power electronic converters. The increased penetration of power electronic-based DERs gives rise to new instability issues, particularly subsynchronous oscillations (SSO) caused by control system interactions, the induction generator effect, or resonance with torsional modes of wind turbines. If poorly damped, such oscillations can compromise the stability of the power grid, resulting in damage or disconnection of equipment and grid sections. Therefore, detecting such frequency components during both planning and operation phases is of paramount importance. This paper proposes a straightforward hybrid method combining Fourier and wavelet analysis (WA) for the online detection of the subsynchronous frequency components in power system measurements. The method leverages the speed of the fast Fourier transform (FFT) and the accuracy of the WA to determine the frequency, amplitude, and damping of SSO events.*
389243 **15:40**	20’	**Fault Redundancy Strategies in MMC-Based High Power Magnet Supply for Particle Accelerators** Manuel Colmenero Moratalla[1], Ricardo Vidal Albalate[1], Francisco Rafael Blanquez Delgado[1], Ramon Blasco-Gimenez[1] *1. European Organization for Nuclear Research* ***Abstract*** *Some particle accelerators require to supply inductive loads with high quality, high value, cycled currents, requiring medium output voltages, in the order of kV. For such an application, Modular Multilevel Converters (MMCs) based on full-bridge cells could be used.* *One of the most interesting features of MMCs is the ability to cope with the failure of one or several cells. For applications requiring high reliability, as it is the case of particle accelerators, the possibility to continue operation in case of component failure can significantly improve the availability of the machine and reduce the amount of redundant equipment. For future colliders, bigger in size, this feature becomes of even greater importance due to the large number of equipment operating simultaneously and the difficulties that usually imply interventions in harsh environments (underground installations, radiation, etc.)* *However, for this application, the failure of one or several cells may have a significant impact on converter operation, especially considering that exquisite output voltage and current qualities are required. Accordingly, this paper proposes strategies to cope with the failure of a cell and studies its impact on converter operation. The simulation results show that it is possible to continue operation after a cell failure without a significant impact on the quality of the output waveforms and without overloading the healthy cells. The paper concludes that using MMCs for powering magnet chains in particle accelerators allows to ride-through the failure of one or several components without limiting its capacity to produce high quality output waveforms.*

385868 **16:00** **Remote presentation**	20’	**Fuse on PiN silicone diode monolithic integration for new fail-safe power converters topologies** Amirouche Oumaziz[1,2,3], Frédéric Richardeau[1,3], Abdelhakim Bourennane[2], Emmanuel Sarraute[1,3], Eric Imbernon[2], Ayad Ghannam[4] *1. University of Toulouse, INP, UPS, LAPLACE ENSEEIHT, France* *2. LAAS-CNRS, University of Toulouse, CNRS, UPS, France* *3. CNRS, LAPLACE, 2 rue Camichel, BP 7122, 31071 Toulouse cedex 7, France* *4. 3DiS Technologies, Miniparc, 478 rue de la découverte, 31670 Labège, France* ***Abstract*** *In this paper, a first concept of monolithic integration of a fuse on a silicon PiN diode is realized and experimentally characterized. An integrated fuse on PiN diode allows fast cut-off, with low I^2T (less than 2 $A^2.s$) and short pre-arcing times (4 to 6 µs). These fuse-on-diode components are intended for failsafe topologies power converter, aiming for more compact and reliable applications. The fuses were electrothermally designed using Comsol Multiphysics™ and TCAD Sentaurus™ simulations were carried out to study their integration on PiN diodes. Characterization and experimental tests were carried out after components realization.*

SS3 SPECIAL SESSION — SESSION: Nanogrids Architectures for Smart Buildings

SS3	**Tuesday May 17 (15:20 PM – 15:40 PM) - ROOM 202** **Chairs:** Giovanni Petrone, Università Degli Studi di Salerno, Italy, Giuseppe La Tona, National Research Council - Institute of Marine Engineering, Italy	
390669 **15:20**	20’	**Day-ahead forecasting of residential electric power consumption for energy management using LSTM encoder-decoder model** Giuseppe La Tona[1], Massimiliano Luna[1], Maria Carmela Di Piazza[1] *1. INM - Consiglio Nazionale delle Ricerche (CNR), Italy* ***Abstract*** *Energy management in smart buildings and energy communities needs short-term load demand forecasting for optimization-based scheduling, dispatch and real-time operation. However, producing accurate forecasting for individual residential households is more challenging compared to the forecasting of load demand at the distribution level, which is smoother and benefits from statistical compensation of errors. This paper presents a dayahead forecasting technique for individual residential load demand based on the Long Short-Term Memory encoder-decoder architecture and considering past and future exogenous inputs. The proposed approach is tailored for use by energy management systems and its performance was validated accordingly. A publicly available dataset was used for validation, and the approach was compared with three other methods, resulting in a reduction of the mean daily error up to 8% Mean Absolute Scaled Error.*

388830 **15:40**	20’	**Energy, environmental and economic analysis of a real photovoltaic based charging station** A. Cabrera-Tobar[1], Nicola Blasuttigh[2], Alessandro Massi Pavan[2], Vanni Lughi[2], Giovanni Petrone[1], Giovanni Spagnuolo[1] *1. Università degli Studi di Salerno, Italy* *2. Università degli Studi di Trieste, Italy* ***Abstract*** *This paper analyzes the energy, economy, and environmental aspects of an e-vehicle charging station installed at the University of Trieste (Italy). The grid-connected charging station has two main components: a PV system and battery energy storage. The Energy Management System controls the energy flow by adopting three levels of priority: i) the electrical vehicle feeding, ii) the storage system recharge, and iii) the power injection into the grid. The analysis uses a data set concerning the charging station and the electrical grid collected for one year. The bases for the analysis are the energy balance of the charging station, its interaction with the grid, the driver’s behavior, and the variation of the CO_2 emissions. The proposed analysis has general validity, and it is applied to the specific charging station. Then, a comparison with a conventional car with similar characteristics is developed.*
388823 **16:00**	20’	**Integrating model predictive control and deep learning for the management of an EV charging station** Gianluca D'amore[1], Ana Cabrera-Tobar[1], Giovanni Petrone[1], Alessandro Massi Pavan[2], Giovanni Spagnuolo[1] *1. Università degli Studi di Salerno, Italy* *2. Università degli Studi di Trieste, Italy* ***Abstract*** *Explicit model predictive control (EMPC) maps offline the control laws as a set of regions as function of bounded uncertain parameters. Then, in online mode, it seeks the best solution within these areas. Unfortunately, the offline solution can be computationally demanding because the number of regions can grow exponentially. Thus, this paper presents the application of deep neural network (DNN) to learn the EMPC’s regions for a photovoltaic-based charging station. The main uncertain parameters in this study are the forecast error of photovoltaic power production and the battery’s state of charge. Additionally, the connection or disconnection of an electric vehicle is considered a disruption. The final controller creates the regions at the start of each prediction time or when a disruption occurs, only using the previously created DNN. The obtained solution is validated using data from an e-vehicle charging station installed at the University of Trieste, Italy.*

SS4 **SPECIAL SESSION** **SESSION: Energy Storage Systems**

SS4. part 1	**Wednesday May 18 (14:00 AM – 16:00 PM) - ROOM 201** **Chairs:** Massimiliano Luna, National Research Council - Institute of Marine Engineering, Italy Walter Zamboni, DIEM - Università Degli Studi di Salerno, Italy	
390297 **14:00**	20’	**Modeling of the thermal runaway phenomenon of cylindrical 18650 Li-ion cells** Paola Russo[1], Sofia Ubaldi[1], Maria Luisa Mele[1] *1. Sapienza University of Rome, Department of Chemical Engineering Materials Environment, Via Eudossiana, 18, 00184 Rome, Italy* ***Abstract*** *The thermal runaway (TR) is the main safety concern of lithium-ion batteries (LIBs). Methods for predicting and preventing TR are critical to achieve greater battery safety. Many researchers have studied the reactions that take place inside the cell and that because of their exothermicity trigger the TR. In this work the coupled electrochemical-thermal model for a lithium-ion cell was extended with contributions from exothermic reactions based on an Arrhenius law to model mechanisms of abuse, which could lead to a thermal runaway. Firstly, differential scanning calorimetry (DSC) tests were conducted on the individual components of the cell to characterize the reactions of the TR process in terms of onset temperature of kinetic parameters. The kinetic parameters of each reaction were identified by the Kissinger method. Then the thermal and kinetics parameters of the reactions occurring during the thermal runaway together with the phenomena involving the electrolyte (i.e., evaporation, boiling and venting) were included in the Battery and Fuel Cell Module of COMSOL Multiphysics simulator, to simulate the behaviour of a cylindrical 18650 cell under thermal abuse conditions. In particular, the results of the model appear to agree with the experimental data, concerning a NCA 18650 cell subjected to radiative heat flux in a cone calorimeter.*
387751 **14:20**	20’	**A Li-ion battery charger with embedded signal generator for on-board electrochemical impedance spectroscopy** Luigi Mattia[1], Giovanni Petrone[1], Walter Zamboni[1] *1. DIEM - Università degli Studi di Salerno, via Giovanni Paolo II 132, 84084 Fisciano, Italy* ***Abstract*** *The development of a battery monitoring system is one of main tasks for applications needing an efficient and well-designed battery storage system. In this framework, a fast, on-board, non-invasive and low-cost diagnosis system has a primary importance. Among the large number of diagnosis techniques, the Electrochemical Impedance Spectroscopy (EIS) is one of the most powerful. It allows one to extract information about the overall state of an electrochemical cell by stimulating it with current or voltage signals with appropriate shapes and frequency. In this work, we present the changes made to a commercial Lithium-ion battery charger to implement a system for the generation of EIS stimuli, preserving large part of the native functions of the battery charger. The stimulation functions are implemented using a field-programmable gate array (FPGA) board, which ensures a good voltage resolution and an optimal frequency range for this kind of applications.*

390065 **14:40** **Remote presentation**	20’	**Numerical assessment of cooling systems for thermal management of lithium-ion batteries** Girolama Airò Farulla[1], Davide Aloisio[1], Valeria Palomba[1], Andrea Frazzica[1], Giovanni Brunaccini[1], Francesco Sergi[1] *1. Consiglio Nazionale delle Ricerche, Istituto di Tecnologie Avanzate per l’Energia “Nicola Giordano”, salita S. Lucia sopra Contesse, 5 – 98126 Messina, Italy* ***Abstract*** *Lithium-ion batteries have the advantages of high energy density, high charge-discharge efficiency, low self-discharge effect and long cycle life that make them suitable in both stationary and mobile applications. They are the most widely used solution in the field of electric vehicles and are increasing their application for stationary applications. Both the life-time and performances are negatively affected by high temperatures so the prevision of the thermal behaviour is a crucial step in the battery modelling.* *Based on an experimental setup, a simplified thermal model was developed to estimate the surface temperatures of a lithium titanate cell from current and voltage measurements. The model was implemented in the COMSOL Multiphysics® Finite Element code. Charge and discharge cycles of the cell were performed and the predicted heat generation used as input of the thermal model. The calibrated model was lastly used to assess two thermal battery management (TBM) cooling systems, in this case applied to a single cell: a passive phase change material (PCM) system and a hybrid PCM/water system. The effects of the PCM thickness and velocity inlet of the water on the cell temperature were investigated. Results showed that, in comparison to the passively air cooled cell, both systems decreased the maximum surface temperatures, thus improving the uniformity of the temperature distribution and keeping the battery in a safe temperature range.*
389048 **15:00**	20’	**Impedance modeling for multichannel EIS in industrial scale vanadium redox flow batteries** Andrea Trovò[1], Walter Zamboni[2], Massimo Guarnieri[1] *1. Department of Industrial Engineering - University of Padua, 35131 Padova, Italy* *2. Dipartimento di ingegneria dell’Informazione ed Elettrica e Matematica applicat (DIEM) - Università degli Studi di Salerno, via Giovanni Paolo II 132, 84084 Fisciano, Italy* ***Abstract*** *The work provides early results obtained with a multichannel EIS system, which were used to identify an equivalent circuit of an Industrial Scale Vanadium Redox Flow Battery (IS-VRFB) stack with a rated power/energy of 9 kW/27 kWh. The single cell impedance is represented with three different models, including a series resistance and an RC loop (RRC model), or a constant phase element (CPE) loop (a ZARC element), or a ZARC element including also a Warburg impedance. The inclusion of the CPE constitutes a substantial improvement in the fit. Conversely, the addition of the Warburg element, which aims to model the mass transfer in the electrochemical process, does not produce significant effects for the frequencies at which we have experimental data. This numerical results are validated against EIS measurements taken on IS-VRFB. Very few analyses of this type are reported in the literature for such batteries. This study set the stage for developing advanced online State of Health (SOH) management for IS-VRFB.*

387555 **15:20**	20’	**Incremental Capacity Analysis as a diagnostic method applied to second life Li-ion batteries** Lucas Albuquerque[1], Fabien Lacressonnière[1], Xavier Roboam[1], Christophe Forgez[2] *1. LAPLACE- Laboratoire Plasma et Conversion d’Energie, Université de Toulouse, CNRS, INPT, UPS, 31055 Toulouse, France* *2. Laboratoire Roberval, FRE UTC-CNRS 2012, Sorbonne universités, Université de Technologie de Compiègne, France* ***Abstract*** *This work is inserted in the context of second life Li-ion batteries: for such storage devices, their first life characteristics are unknown and a simple capacity measurement might not be sufficient to fully characterize and get it ready for its second life. The Incremental Capacity Analysis (ICA) was used in this study to give a more intimate diagnosis of the batteries’ Degradation Modes (DMs), providing a link with physical degradation phenomena. This method was applied to a lithium-ion battery module (NMC/Graphite) which was used in an electrical vehicle and to a single cell from a similar module in order to verify its potential use in this context. Both IC curves were then compared to a DM simulation using the ‘Alawa software, capable of simulating different ageing phenomena and their effects on the IC curves. Moreover, this work gives an intrinsic view and explanation of the IC signature for the mentioned battery technology.*
386248 **15:40**	20’	**Experimental Development of Embedded Online Impedance Spectroscopy of Lithium-Ion Batteries** Sudnya Vaidya[1,2], Daniel Depernet[1], Salah Laghrouche[1], Daniela Chrenko[1] *1. Franche-Comté Électronique Mécanique, Thermique et Optique - Sciences et Technologies (UMR 6174), Université de Franche-Comté, Ecole Nationale Supérieure de Mécanique et des Microtechniques, Centre National de la Recherche Scientifique : UMR6174, Université de Technologie de Belfort-Montbeliard : UMR6174* *2. Université Bourgogne Franche-Comté* *Université de Technologie de Belfort-Montbeliard* ***Abstract*** *The need for greener energy sources their storage, management and monitoring, are at the core of research around the globe. This paper focuses on the first step of developing an embedded system that is capable of conducting fast online impedance spectroscopy of batteries for integrated monitoring throughout the battery life cycle in real-world industrial and residential applications such as electric vehicles, energy storage systems in energy grids etc. It significantly covers the experimental methodology to conduct online EIS data its treatment and conversion into the frequency domain by Fast Fourier transformation. Selection of an equivalent circuit model to define various electrochemical characteristics of Li-Ion batteries. Further, it describes the exploitation of EIS data by an optimisation algorithm to estimate the parameters of equivalent circuit model closely resembling that to Li-battery, accuracy between various optimisation methods is compared. Finally, the proposed online EIS-ECM modelling methodology is validated by experimental tests and the results prove the capability of the test bench to design and evaluate monitoring methodology before their embedded implementation.*

SS4. part 2	**Thursday May 19 (10:30 AM – 12:30 PM) - ROOM 201** **Chairs:** Giuseppe La Tona, National Research Council - Institute of Marine Engineering, Italy Matthieu Urbain, Université de Lorraine, LEMTA, Nancy, France	
385892 **10:30**	20’	**Modeling the non-linearities of charge-transfers and solid electrolyte interphase resistances for a sodium-ion battery with a hard carbon electrode** Houssam Rabab[1], Nicolas Damay[1], Fernanda Vendrame[1], Christophe Forgez[1], Asmae El Mejdoubi[2] *1 : Université de Technologie de Compiègne - Roberval (Mechanics, energy and electricity), Centre de recherche Royallieu - CS 60319 - 60203 Compiègne cedex, France* *2. Tiamat, France* ***Abstract*** *Sodium-ion batteries are a promising technology whose performance are getting closer to those of lithium-ion batteries. The electrochemical phenomena are mostly the same for these two technologies, but the sodium-ion battery studied in this paper has a negative electrode made of hard carbon “HC” in which different phenomenon occurs when state of charge “SoC” decreases. In this paper, we characterized this sodium-ion battery thanks to a physic-based model that can represent the non-linearities of the charge transfers and solid electrolyte interphase “SEI” resistances. In this initial study, we found that this model represented accurately the battery non-linearities for high SoC, making it able to characterize its charge transfers and SEI (eg. for diagnosis purpose). However, the model failed to represent the cell behavior below SoC 40-50%, suggesting that it should be improved for batteries with HC electrodes.*
389813 **10:50**	20’	**Tool for optimization of sale and storage of energy in wind farms** Eloy Celades[1], Emilio Pérez[2], Nestor Aparicio[2], Ignacio Peñarrocha-Alós[2] *1. GALT Automation, C/ Santa Maria Rosa Molas 40 1º B, 12004 Castell´o de la Plana, Spain* *2. ESID – Universitat Jaume I, Av. Vicent Sos Baynat, s/n, 12071 Castello de la Plana, Spain* ***Abstract*** *The control tool presented in this paper aims to increase the profitability of a wind farm equipped with batteries by managing the storage and sale of electrical energy to the grid. To do this, an algorithm is developed that is responsible for selling a greater amount of energy on the hours with higher market prices and reducing penalties due to generation imbalances. It is in charge of obtaining forecasts of both wind and electricity market prices from different application programming interfaces, in order to decide the electricity commitment for the daily and intraday markets. The decision depends on the correct estimation of energy produced and stored in the battery as well as the penalties due to prediction errors. The results show that being able to adequately adapt the energy committed in the intraday market makes the use of the battery practically unnecessary, which would only be profitable if its price were less than a certain value.*

389418 **11:10**	20’	**An electrical equivalent model of a metal hydride hydrogen storage system** Olivier Lefranc[1], Henri Schneider[1], Christophe Turpin[1], Olivier Rallières[1], Maël Durand[1] *1. LAPLACE, Institut National Polytechnique de Toulouse – INPT, Toulouse, France* ***Abstract*** *In this work, we study the modeling of a AB5 metal hydride-based hydrogen storage tank. A database is created based on discharge curves at different temperature and hydrogen flowrate setpoints. An electrical equivalent model is developed to analyse the desorption during operation. The metal hydride contained in the tank is unknown and we don’t have any information about the characteristics of the material. We aim to simulate the system without having to plot traditional Pression-Composition-Temperature curves. The parameters of the model are found by fitting experiment and simulation using CMA-ES algorithm. The simulation results offer good results with a maximal error of 7.96%.*
381964 **11:30**	20’	**Influence of aging on SEI and charge transfer resistances and their dependence on current and temperature for a Li-ion NCA+NMC/graphite cell** Fernanda Vendrame[1,2], Nicolas Damay[1], Houssam Rabab[1], Christophe Forgez[1], Marie Sayegh[2] *1. Université de Technologie de Compiègne - Roberval (Mechanics, energy and electricity), Centre de recherche Royallieu - CS 60319 - 60203 Compiègne cedex, France* *2. SAFRAN Electrical and Power - 70-80 Rue Auguste Perret, 94000 Créteil, France* ***Abstract*** *Modeling the electrical behavior of cells is often complex because several parameters have to be determined simultaneously, which may lead to inconsistencies and inaccuracies. In the present paper, we modeled the surface resistance by using a method based on rules of dependence, already presented in the literature, which makes it possible to separate the contributions of the SEI (Solid Electrolyte Interphase) layer and the charge transfer as a function of the temperature and the current. A physically consistent model is able to provide a better estimate of the surface resistance values at untested operating points. The main contributions of this work are to transpose this method to an NCA+NMC / graphite+SiO cell and to show that the proposed model is easier to recalibrate as the cell ages than interpolation tables. Besides, the proposed experimental protocol reduces the time needed for testing. By testing cells at different states of health, it was observed that the charge transfer resistance increased with both cycling and calendar aging and that the SEI resistance also increased in both cases because of the high temperatures to which the cells were subjected.*
388401 **11:50**	20’	**Modeling battery aging through high-current incremental capacity features in fast charge cycling** Ludovico Lombardi[1], Eric Monmasson[2], Brian Ospina Agudelo[1,2], Walter Zamboni[1] *1. DIEM - Università degli Studi di Salerno, via Giovanni Paolo II 132, 84084 Fisciano, Italy* *2. Laboratoire SATIE, CY Cergy Paris Université, 95000 Neuville-sur-Oise, France* ***Abstract*** *In this work, the area under the peak on the high current incremental capacity curve is proposed as a capacity indicator in a multistep fast charging scenario. The study is conducted over 94 batteries from a publicly available dataset from the Toyota research institute, including the data of batteries cycled under fast charging conditions with one- or two-step fast constant-current charge phases up to 80% state of charge, followed by a 1C charge until complete charge. A logarithmic model with two fitting parameters is proposed to represent the capacity versus peak area relationship.*

388390 **12:10**	20’	**A survey of Energy Management Systems considering battery state of health preservation in microgrid applications** Maria Carmela Di Piazza[1], Massimiliano Luna[1], Giuseppe La Tona[1] *1. INM - Consiglio Nazionale delle Ricerche (CNR), Via U. La Malfa, 153, 90146 Palermo, Italy* ***Abstract*** *Electrochemical storage systems play an increasingly central role in microgrids, providing several services which allow for more flexible and reliable operation. Lifetime of battery storage systems is a critical aspect to consider for their sustainable and cost-effective employment. In this paper a survey of energy management systems (EMSs) designed to contribute to battery lifetime extension is presented. To pursue this objective, the design of EMSs must rely on suitable battery degradation models, the most significant of which have been retrieved from the technical literature and described as well.*

SS5 **SPECIAL SESSION** **SESSION: Optimization in complex electrical systems**

SS5	**Wednesday May 18 (16:30 PM – 18:10 PM) - ROOM 201** **Chairs :** Salvy Bourguet, Nantes Université, IREENA, France Benoit Delinchant, Univ. Grenoble Alpes, CNRS, Grenoble INP, G2Elab, France	
388709 **16:30**	20’	**Optimal Sizing of Tramway Electrical Infrastructures using Genetic Algorithms** Anass Boukir[1,3], Vincent Reinbold[1], Florence Ossart[1], Jean Bigeon[2], Paul-Louis Levy[3] *1. Laboratoire de Génie Electrique et Electronique de Paris, Université Paris-Saclay, CentraleSupélec, CNRS, France* *2. LS2N, Nantes Université, Centrale Nantes, CNRS, France* *3. ARTELIA Group, France* ***Abstract*** *The increasing electrification of urban public transports requires improving the design of the electrical infrastructures to take into account all the technical and financial challenges involved in the creation of a new line. This paper presents a new optimization tool dedicated to the sizing of tramway electrical infrastructures: power substations, overhead transmission lines, feeders and equipotential bonding. The purpose is to determine the number, positions and technical characteristics of all these components to achieve the best trade-offs between investment costs, energy costs and the quality of the traffic power supply. The sizing problem is formulated as a multi-objective optimization problem and solved using the NSGA-II genetic algorithm. The proposed method is applied to a simple test case and gives good results.*

388558 **16:50**	20’	**User experience inquiry to specify COFFEE: a Collaborative Open Framework For Energy Engineering** Sacha Hodencq[1], Fabrice Forest[2], Théo Carrano[1], Benoit Delinchant[1], Frédéric Wurtz[1] *1. Université Grenoble Alpes, CNRS, Grenoble INP, G2Elab, France* *2. Université Grenoble Alpes - INNOVACS, France* ***Abstract*** *The aim of this article is to introduce COFFEE, a concept of open and collaborative platform in the field of electrical engineering. The platform intends to make energy research accessible, and improve collaborations between researchers, public authorities, design offices and citizen collectives. The COFFEE concept is presented supported by a literature review on open energy modeling and collaborative platforms. Following a "user experience" inquiry conducted with a representative panel, the results are used to specify a first implementation of the COFFEE concept, and can serve as guidelines for the implementation of open energy modelling platforms. These platforms could become the spearheads of electrical engineering laboratories, promoting reproducibility and collaborations between energy stakeholders.*
389768 **17:10**	20’	**Auto-adaptive construction algorithm of a surrogate model in order to approximate costly models for a lifecycle optimization** Marvin Chauwin[1], Hamid Ben Hamed[1], Melaine Desvaux[1], Damien Birolleau[2] *1. SATIE Laboratory, ENS Rennes, France* *2. RENAULT S.A.S., Technocentre, France* ***Abstract:*** *This article presents a generic and self-adaptive construction algorithm for a surrogate model. This method makes use of two major tools: Latin HyperCube, which serves to efficiently spread a large number of samples; and Kriging, which is very efficient for surrogate modeling in the domain of black box models. The efficiency of this method is investigated in the case of a finite element model of a surface permanent magnet synchronous machine. During this study, Kriging surrogate models are compared with various samples in terms of both accuracy of construction and calculation speed. Next, the self-adaptative algorithm is applied in order to derive an accuracy criterion in a minimal amount of time and compare one with a Kriging model built using the same number of samples, yet without our tool to determine any accuracy lost due to the black box feature of the model and the hypotheses used.*
397961 **17:30** **Remote presentation**	20’	**Optimization of Neural Network-based Load Forecasting by means of Whale Optimization Algorithm** Pooya Valinataj Bahnemiri[1], Francesco Grimaccia[1], Sonia Leva[1], Marco Mussetta[1] *1. Politecnico di Milano - Department of Energy, France* ***Abstract*** *Electric load forecasting is of utmost importance for governments and power market participants for planning and monitoring load generation and consumption. Reliable Short-Term Load Forecasting (STLF) can guarantee market operators and participants to manage their operations correctly, securely, and effectively. This paper present the optimization of neural networks for power forecasting by means of whale optimization algorithm: two types of artificial neural networks namely, Feed-Forward Neural Network (FNN) and Echo State Network (ESN) have been used for STLF. ESN’s simplicity and strength have room for improvement. Therefore, an optimization algorithm called the Whale Optimization Algorithm (WOA) has been used to improve ESN’s performance.WOA-ESN was used for STLF of the first case study, namely Puget power utility in North America. The considered forecasting error indicators showed significant accuracy and reliability.WOA-ESN model and recursive approach resulted in better accuracy measures in terms of standard performance metrics.*

389704 **17:50**	20’	**A Comparative Study of Existing Approaches for Modeling the Incident Irradiance in Bifacial Panels** Soufiane Gharifi[1,2,3], Maxime Darnon[2,3], Arnaud Davign[1,4], Joao Trovao[5], Dhaker Abbe[1,4] *1. Laboratoire d’Electrotechnique et d’Electronique de Puissance (L2EP), France* *2. Laboratoire Nanotechnologies Nanosystèmes (LN2), CNRS, France* *3. Institut Interdisciplinaire d’Innovation Technologique (3IT), Université de Sherbrooke, Canada* *4. Ecole des Hautes Etudes d’Ingénieur (HEI), France* *5. e-TESC Lab., Université de Sherbrooke, Canada* ***Abstract*** *Accurate modeling of bifacial module energy production is conditioned to the correct modeling of the front and rear irradiance. This paper compares the existing approaches used to estimate the incident irradiance on the back side and the front side of a photovoltaic (PV) bifacial module, by studying the performance of each model in terms of accuracy and computation time. In this study, we have selected three software with different approaches. We started with Bifacial_radiance which uses the ray-tracing technique. The second software is Sandia model which is a three-dimensional implementation of view factor method under MATLAB™. We complete our study with pvfactors that employs a two-dimensional configuration factor model. This study aims to propose the most time-efficient way to compute the irradiances received by bifacial panels, which will serve to predict the energy production of power plants. Having a fast model allows to develop efficient real-time management strategies for power supply systems that use bifacial modules. According to this study, pvfactors has the lowest execution time and gives almost the same output results as Bifacial_radiance and Sandia model that use complex algorithms.*

SS7 **SPECIAL SESSION** **SESSION: Energy management of FCHEV**

SS7	**Tuesday May 17 (16:50 PM – 18:10 PM) - ROOM 201** **Chairs:** Samir Jemei, Université de Bourgogne Franche-Comté, FEMTO-ST, Belfort, France Alireza Payman, Le Havre-Normandie University, Le Havre, France

389485 **16:50**	20’	**Electrical and thermal modelling of PEMFCs for naval applications** Ayoub Igourzal[1,2], François Auger[2], Jean-Christophe Olivier[2], Guenael Lesolliec[1] *1. CEA Tech, France* *2. Institut de recherche en Energie Electrique de Nantes (IREENA), France* ***Abstract*** *This paper presents a semi-empirical model of Proton Exchange Membrane Fuel Cell (PEMFC), combining electrical and thermal phenomena and system degradations. The originality of our approach is the link between activation and diffusion phenomena by using a semi-empirical equation to create a new fast and accurate PEMFC model. Then, a degradation model is defined and adapted to energy management needs. The aim of this design is to study fault tolerant multi stack Fuel Cell (FC) systems, to study their interactions with converters and to design optimal control and adaptative management rules.* *The degradation model is used to adapt management laws according to the state of health of each stack. This work also offers an exhaustive analysis of the existing models available in the literature including a set of models compatible with the needs of Modular Fuel Cells (MFC) studies*

389727 **17:10**	20’	**Experimental study of the cold start capabilities of a closed cathode PEM fuel cell** Jérémy Villaume[1], Elodie Pahon[1], Alexandre Ravey[1], Samir Jemeï[2] *1. FEMTO-ST Institute, FCLAB, Univ. Bourgogne Franche-Comté, UTBM, CNRS, France* *2. FEMTO-ST Institute, FCLAB, Univ. Bourgogne Franche-Comté, CNRS, France* ***Abstract*** *Starting a fuel cell system under subfreezing temperature remains a technological challenge for a large-scale distribution of this kind of power generator, especially in embedded applications. In this paper, investigations on the cold start capabilities of a 700 W proton exchange membrane fuel cell (PEMFC) are performed. The study is based on a potentiostatic control of the load during the start-up procedure. Thanks to the proposed methodology, the fuel cell was able to start without assistance from a temperature of -10°C in 105s.*
388633 **17:30**	20’	**A Q-learning-based Energy Management Strategy for a Three-Wheel Multi-Stack Fuel Cell Hybrid Electric Vehicle** Razieh Ghaderi[1], Mohsen Kandidayeni[1], Loïc Boulon[1], João P. Trovão[1] *1. Département de Génie Electrique et Génie Informatique (UQTR), France* ***Abstract*** *This paper addresses the design of an adaptive energy management strategy (EMS) for a multi-stack fuel cell hybrid electric vehicle (MFC-HEV) using reinforcement learning (RL). The proposed strategy has two operating layers. In the first layer, the models of the FC and battery are updated online by recursive least squares (RLS) and then the updated characteristics are used by Q-Learning algorithm for distributing the power among the three FCs and the battery pack. The performance of the suggested strategy is compared with dynamic programming (DP) under a real driving cycle. The results show that there is almost a 7% performance difference in terms of total cost (power sources’ degradation and hydrogen consumption) between the proposed strategy and DP under the considered driving cycle.*
386000 **17:50**	20’	**Minimizing Hydrogen Consumption of a Hybrid Multi-Stack Fuel Cell Vehicle based on a Two-Layer Predictive Strategy** Mohammadreza Moghadari[1], Mohsen Kandidayeni[2], Loïc Boulon[1], Hicham Chaoui[3] *1. Université du Québec à Trois-Rivières, Québec* *2. Université de Sherbrooke, Canada* *3. Carleton University, Canada* ***Abstract*** *In recent years, using the multi-stack system in a fuel cell (FC) hybrid electric vehicle (HEVs) has been noticed due to its modularity and higher efficiency. Minimizing hydrogen consumption is one of the essential issues to maximize such vehicles' economic potential. Hydrogen consumption reduction is an indispensable problem in a multi-stack configuration. This paper aims to diminish the hydrogen consumption of an FC-HEV powered by four FCs and a lithium-ion battery. A two-layer energy management strategy (EMS) is executed to reduce hydrogen consumption to reach this purpose. The upper layer is a rule-based strategy that decides how many FCs should be ON based on the requested power and battery state of charge (SOC). The lower layer applies model predictive control (MPC), wherein hydrogen consumption is considered an objective function. Dynamic programming (DP) is utilized to evaluate the performance of this strategy to compare the results. The results show that this strategy matches DP well and can be a trustworthy choice for the multi-stack FC-HEVs.*

SS10 SPECIAL SESSION

SESSION: Artificial Intelligence for smart grids

SS10. part 1	Wednesday May 18 (14:00 AM – 16:00 PM) - ROOM 204 **Chairs :** Bruno Francois, Centrale Lille Institute, L2EP, Lille, France Vincent Debusschere, Université Grenoble Alpes, G2ELAB - ENSE3 Grenoble INP, France	
389109 **14:00**	20’	**Social data to enhance typical consumer energy profile estimation on a national level** Amr Alzouhri Alyafi[1], Pierre Cauchois[2], Benoit Delinchant[1], Alain Berges[2] *1. G2ELab - Laboratoire de Génie Electrique de Grenoble, 21 avenue des Martyrs, 38031 Grenoble, France* *2. ENEDIS, 345 avenue G. Clemenceau, Nanterre, France* ***Abstract*** *Since the electrical grid creation, assessing the electricity demand is essential as we need to match the energy production/demand at all times. Load analysis is essential in improving the reliability and efficiency of the grid. Beside regular human activities, the main impact factor which explains consumption variations is the outside temperature. But there are still unpredictable variations that are mainly coming from arising social events. To build a better understanding of these variations, this work will focus on how to detect these events from social media and how to quantify their impact on residential and professional typical profiles for energy demand.*
389837 **14:20**	20’	**A Review of Frequency Control Techniques using Artificial Neural Network in Urban Microgrid** Louise Petit[1], Bruno Francois[1] *1. Ecole Centrale de Lille - Laboratoire d'Électrotechnique et d'Électronique de Puissance (L2EP) - 59655 Villeneuve d'Ascq, France* ***Abstract*** *The increasing penetration of intermittent Renewable Energy Sources (RES) induces more instability of the grid and constraints on the Energy Management (EM). Microgrids (MG) are more and more experimented to better implement local flexibilities for dynamically balancing the production and load demand inside a specific area as districts of a city, as example. New solutions like Artificial Intelligence (AI) and Artificial Neural Networks (ANN) are being developed in order to improve the real-time energy management. Specifically, this paper deals with the operational management of energy resources via the tuning of the frequency control parameters to satisfy the load demand. A non-exhaustive review of ANN techniques for enhancing the frequency control in microgrids is proposed. ANN techniques are shown to be performing better than other AI techniques on the specific cases reported here.*

394559 **14:40**	20’	**Stator Interturn Short-Circuits Detection in the PMSM Drive by using Current Symmetrical Components and Selected Machine Learning Algorithms** Przemyslaw Pietrzak[1], Marcin Wolkiewicz[1] *1. Wroclaw University of Science and Technology, 50370 Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland* ***Abstract*** *The fault diagnosis of Permanent Magnet Synchronous Motors (PMSMs) has been the subject of much research in recent days. This is due to the growing safety and reliability requirements for drive systems. This paper concerns detection and classification of the PMSM stator interturn short-circuits (ITSC) by using selected machine learning algorithms. The spectral analysis of symmetrical current components is applied for ITSC symptom extraction. The utilized and compared algorithms are K-Nearest Neighbours (KNN), Support Vector Machine (SVM), Naive Bayes (NB) and Multilayer Perceptron (MLP). Experimental results confirm that the use of the KNN, SVM and MLP classifiers allows for ITSC detection with high effectiveness. The most effective is KNN, which is simple to implement and not computationally complex.*
384158 **15:00**	20’	**Detecting Cyberthreats in Smart Grids Using Small-Scale Machine Learning** Tarek Berghout[1], Mohamed Benbouzid[2,3] *1. Laboratory of Automation and Manufacturing Engineering, University of Batna 2, 05000 Batna, Algeria* *2. University of Brest, UMR CNRS 6027 IRDL, 29238 Brest, France* *3. Shanghai Maritime University, Logistics Engineering College, 201306 Shanghai, China* ***Abstract*** *Due to advanced monitoring technologies including the plug-in of the cyber and physical layers on the Internet, cyber-physical systems are becoming more vulnerable than ever to cyberthreats leading to possible damage of the system. Consequently, many researchers have devoted to studying detection and identification of such threats in order to mitigate their drawbacks. Among used tools, Machine Learning (ML) has become dominant in the field due to many usability characteristics including the blackbox models availability. In this context, this paper is dedicated to the detection of cyberattacks in Smart Grid (SG) networks which uses industrial control systems (ICS), through the integration of ML models assembled on a small scale. More precisely, it therefore aims to study an electric traction substation system used for the railway industry. The main novelty of our contribution lies in the study of the behaviour of more realistic data than the traditional studies previously shown in the state of the art literature by investigating even more realistic types of attacks. It also emulates data analysis and a larger feature space under most commonly used connectivity protocols in today's industry such as S7Comm and Modbus.*

380810 **15:20**	20’	**Discussion on classification methods for lifetime evaluation of a lab-scale SiC MOSFET power module** Malorie Hologne-Carpentier[1], Bruno Allard[2], Guy Clerc[2], Hubert Razik[2] *1. LabECAM, ECAM Lasalle, Université de Lyon, 69321 Lyon, France* *2. AMPERE, Université de Lyon, INSA Lyon, UCB Lyon, 69100, Villeurbanne, France* ***Abstract*** *This paper focuses on classification methods for evaluating the lifetime consumption (LC) of power electronics modules. The generalization of power electronics devices introduces new issues concerning the reliability of equipment, especially in the transportation field. To meet these expectations, this paper discusses an approach to evaluate the percentage of lifetime of a lab-scale SiC MOSFET power module, designed for an aircraft application. This module is based on a planar technology, and presents typical failure modes concerning the SiC MOSFET chip itself and its environment. The modules have been aged on a specific instrumented test bench to trigger the expected failure modes. Thanks to it, a large database of parameters have been obtained in order to find a relevant failure signature. Once the signature obtained, a comprehensive solution is required to classify the signatures into relevant classes related to the module LC. To meet the issue, three types of classification have been tested with learning data set: Support Vector Machine, k-Nearest Neighbors and neural network. The last contribution of this paper is a discussion on the evaluation of the percentage of lifetime consumption of a new test module thanks to the most promising models obtained from the learning data set.*
388801 **15:40**	20’	**Energy management system by deep reinforcement learning approach in a building microgrid** Mohsen Dini[1], Florence Ossart[1] *1. Laboratoire de Génie Electrique et Electronique de Paris, Sorbonne Université, Université Paris-Saclay, CentraleSupélec, Centre National de la Recherche Scientifique (UMR8507), France* ***Abstract*** *In this paper, we study the application of the deep reinforcement learning to train a real time energy management system using the DQN algorithm. We consider a building–scale microgrid with PV production, non-shiftable loads, a battery unit, and a unidirectional connection to the utility grid. The price of electricity follows peak / off-peak rates. The objective of the energy management system (EMS) is to minimize the operational cost of the microgrid without any forecaster, but based on past data. The EMS is designed to respond in real-time to the net energy demand of the microgrid and control the battery via a discrete set of actions. Numerical experiments are conducted and results show the efficiency of the training phase and the reliability and nearoptimal performance of the trained agent.*

SS10. part 2	Thursday May 19 (10:30 AM – 12:30 PM) - ROOM 202 **Chairs :** Vincent Debusschere, Université Grenoble Alpes, G2ELAB - ENSE3 Grenoble INP, France Bruno Francois, Centrale Lille Institute, L2EP, Lille, France	
394693 **10:30**	20’	**Diagnostic of the PMSM stator and rotor faults with the use of shallow neural networks** Maciej Skowron[1], Teresa Orłowska-Kowalska[1], Czesław T. Kowalski[1] *1. Wroclaw University of Science and Technology, 50-370 Wrocław, Poland* ***Abstract*** *This paper presents the application of shallow neural networks (NN): multi-layer perceptron (MLP), self-organizing Kohonen maps (SOM) to the early detection and classification of the stator and rotor faults in PMSM. The neural networks were trained based on the vector coming from measurements on the real object. The elements of the input vector of NN constituted the selected amplitudes of the diagnostic signal spectrum. The test object was a 2.5 kW PMSM motor supplied by the frequency converter operating in a closed-loop control structure. The experimental verification of the proposed diagnostic system was carried out for variable load conditions and values of the supply voltage frequency. The research presented in the article confirm the possibility of detection and assessing the individual damage of stator winding and permanent magnets as well as the simultaneous faults of the PMSM stator and rotor.*
388911 **10:50**	20’	**Evolutionary Algorithms for Risk-based Energy Resource Management considering Conditional Value-at-Risk Analysis** José Rafael Guedes Almeida[1], Joao Soares[1], Fernando Lezama[1], Zita Vale[2], Bruno Francois[3] *1. GECAD Research Center, Polytechnic of Porto, R. Dr. António Bernardino de Almeida 431, 4200-072 Porto, Portugal* *2. Polytechnic of Porto, R. Dr. António Bernardino de Almeida 431, 4200-072 Porto, Portugal* *3. Centrale Lille, Junia, ULR 2697 - L2EP, University Lille, Arts et Metiers Institute of Technology, 42 Rue Paul Duez, 59000 Lille, Lille, France* ***Abstract*** *With the high penetration of distributed energy resources that we see today, an evolution of energy management systems is necessary. The complexity of the energy resource management problem increases with this high integration of renewables and other resources such as electric vehicles. The distributed resources bring uncertainty and variability, which opens the possibility of a special event, also called an extreme event. Despite the low probability of occurrence, such extreme events pose a high risk to the scheduling of resources. In this paper, we propose a day-ahead energy resource management model for an aggregator inserted in a 13-bus distribution network with high penetration of DER. In the proposed model, we consider a risk-based mechanism through the conditional value-at-risk method for risk measurement in the existence of these extreme events. Results show that implementing risk-averse strategies reduces the cost of the worst scenario in all tested algorithms, reducing scheduling costs. HyDE-DF showed a more significant reduction with a 74%.*

385169 **11:10**	20’	**Online detection of PV degradation effects through ANN Classifier** Giovanni Petrone[1], Rudy Alexis Guejia Burbano[1], Vincenzo Noviello[1] *1. Universita degli Studi di Salerno, Dipartimento di Ingegneria dell’Informazione ed Elettrica e Matematica Applicata, Via Giovanni Paolo II, 132, 84084 Fisciano, Italy* ***Abstract*** *Photovoltaic (PV) system reliability and its service life are strongly dependent on the state of health of PV panels, thus methodologies and technical solutions for the accurate monitoring and the on-line diagnosis of the PV panels are fundamental for the maintenance of current PV installations and the development of new ones. In this paper a model based diagnostic technique combined with a neural network classifier has been developed for an early detection of PV panel degradation. The proposed approach is suitable for PV applications where each panel, or a small number of panels, is connected to a dedicated power converter for achieving both a distributed maximum power point tracking and a detailed PV monitoring. The diagnostic method has been tested on the Pynq-z2 platform based on the system-on-chip architecture, nevertheless different board could be used for implementing the proposed approach on embedded system for the on-line operation.*
388766 **11:30**	20’	**Load Consumption Characterization and Tariff design based on Data Mining Techniques** Sergio Ramos[1], Hugo Morais[2], Joao Soares[1], Zahra Foroozandeh[1], Zita Vale[1] *1. Polytechnic of Porto, School of Engineering (ISEP), Rua Dr. António Bernardino de Almeida, 431 Porto, Portugal* *2. INESC-ID, Department of Electrical and Computer Engineering, Instituto Superior Técnico (IST), Avenida Rovisco Pais, 1049-001 Lisboa, Portugal* ***Abstract*** *In the context of intelligent management of electricity consumption, the knowledge of the customers’ representative load consumption, and, consequently, of how and when this consumption occurs, constitutes a competitive advantage, in terms of positioning in the electricity market. This work presents the establishment of a methodology to characterize the electricity consumption of industrial consumers based on data mining techniques. A classification model was also implemented to classify new consumers in one of the obtained classes. Clustering validity indices were used to evaluate the clustering partition and also to support the decision of the best number of classes. Based on the results obtained from the load characterization approach, a methodology for defining electricity tariff structures is implemented taking into account the typical consumption profile and the evolution of electricity prices formed in the market. The results point to a clear distinction between clusters as well as tariff structures adapted to the identified set of industrial customers.*
388619 **11:50**	20’	**Model-free Detection of Distributed Solar Generation in Distribution Grids Based on Minimal Exogenous Information** Aleksandr Petrusev[1], Rémy Rigo-Mariani[1], Vincent Debusschere[1], Patrick Reignier[2], Nouredine Hadjsaïd[3] *1. Univ. Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), G2Elab, 38000 Grenoble, France* *2. Univ. Grenoble Alpes, CNRS, Grenoble INP (Institute of Engineering Univ. Grenoble Alpes), LIG, 38000 Grenoble, France* *3. Nanyang Technological University, Singapore*

		Abstract *In recent years, the importance of PV generation data for distribution system operations has increased. However, some behind-the-meter solar installations are still not registered with the system operator and are not necessarily monitored at a centralized level. This "hidden" generation, therefore, increases the difficulty to operate securely and efficiently the distribution grid. This paper introduces a tool dedicated to the automatic detection of such behind the- meter solar generation. It is designed to discriminate the nodes with and without local PV generation and is aimed at a high accuracy, without local measurements, thus preserving privacy and increasing security. The tool consists of a neural network coupled with an analytical classification algorithm, which considers only exogenous information (i.e., node consumption and temperature data). Open-access consumption and solar radiation data are used to feed the simulation of a 14-nodes CIGRE distribution grid used to validate the proposed approach. The implemented solution is tested across all the nodes of the selected grid. The sensitivity of the results is analyzed with regard to the level of PV penetration and the period of observation. The tool is able to recognize the nodes with a new PV installation with an accuracy of up to 100 %, depending on exogenous conditions.*
388875 **12:10**	20'	**Learning-based Current Estimator for Power Converters Operating in Continuous and Discontinuous Conduction Modes** Gerardo Becerra[1], Fredy Ruiz[2], Diego Patino[3], Minh Tu Pham[4], Xuefang Lin-Shi[4] *1. Universidad Nacional Abierta y a Distancia (UNAD) CEAD José Acevedo y G ómez, Transversal 31 No. 12-38 sur, Bogota, Colombia* *2. Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italia* *3. Pontificia Universidad Javeriana, Facultad de Ingenieria - Edificio 42 Cra. 7 No. 40-62, Bogota, Colombia* *4. Univ. Lyon, INSA Lyon, Université Claude Bernard Lyon 1, Ecole Centrale de Lyon, CNRS, Ampère, UMR5005, 69100 Villeurbanne, France* ***Abstract*** *The problem of current estimation in switched power converters operating in continuous and discontinuous conduction modes is considered. A method is presented for direct design of an estimator without exact knowledge of the mathematical model of the system. The structure of the proposed method is simpler than other approaches found in the literature, which use hybrid or averaged models to represent the dynamics of the power converter in each operating mode. An algorithm implementation using parallel computation and dimensionality reduction techniques for improving the execution performance is described. The method is demonstrated in the case of the pulse-width modulated SEPIC DC-DC converter, where simulation and experimental results are discussed. The proposed method shows better estimation results with respect to other well known model-based and data-based approaches.*