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A Novel Nature-Inspired Approach for Wind Farm Location Optimization Considering Wake Effects

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A Novel Nature-Inspired Approach for Wind Farm Location Optimization Considering Wake Effects

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ABSTRACT

The optimal location of the wind turbines (WTs) is a critical component in the design of the WT, which can guarantee maximum output power. For that, several recent methodologies have been carried out for optimizing wind turbines in a wind farm using different optimization algorithms. This paper proposes a novel approach for the optimization of wind farm layout using Quantum-behaved particle swarm optimization (QPSO) algorithm. Three case studies are considered to express the presence of wake impact. The effectiveness of the proposed approach is validated through simulations conducted in MATLAB. The performance findings are compared against results from previously published works, revealing that the proposed optimization technique consistently achieves higher total power output and improves the total efficiency of the WT.

KEY WORDS

Wind farm location optimization ; wake model ; quantum-behaved particle swarm optimization (QPSO) algorithm ; wind turbine

I. INTRODUCTION

The growing of global demand for clean and renewable energy sources (RES) led to a rapid increase in wind energy development [1], [2], [3] and [4]. As one of the most advanced and economically viable sources of RES, wind power is indispensable to the transition toward sustainable energy systems. However, the efficiency of wind farms are highly dependent on the optimal location of wind turbines (WTs). One of the most powerful parameters that affect this efficiency is the wake effect, the decrease in wind speed and rise in turbulence downstream of a WT due to its operation. In the last decade, a number of optimization approaches have proposed to address WFLO problems. They vary from classical mathematical modeling to much more advanced nature-inspired metaheuristic approaches. Of them, Swarm Intelligence (SI) algorithms as Particle Swarm Optimization (PSO), Genetic Algorithms (GA), and their hybrids have been highly promising because they can address the nonlinearity, multi-modality of WFLO problems. There are some considerable studies that have touched on certain axes of the WFLO problem. For instance, area rotation technique and fixed point choice method in [5] tried to align wind farm arrangements with freestream wind directions for more efficient power generation. Yet, such methods were susceptible to slow convergence and computational cost. One of the initial investigations by [6] optimized the quantity and positioning of WTs for different wind conditions in formulating the WFLO problem, which was further improved in [7] with altered of GA parameters. There were subsequent developments in [8] to suggest enlarging wind farm boundaries to create greater flexibility in the arrangement, with [9] looking at a threefold optimization of turbine spacing, location direction, and control methodology. Adaptive PSO was applied in [10] to develop greater capacity for global search with better trade-offs between power generation and capital expenditure. Other works have aimed to balance multiple objectives. A PSO variant with multiple adaptive mechanisms was investigated in [11] to further enhance performance, but lacked sufficient attention to turbine spacing and the integration of restricted zones. These developments reflect the tremendous step forward achieved in WFLO problem. However, there remain difficulties in the accurate modeling of wake effect, multi-dimensional design constraints, and compromise between power generation and cost-efficiency. In the paper, a novel hybrid algorithm is presented: Quantum-Behaved Particle Swarm Optimization (QPSO). The approach aims at global search capability improvement by quantum-behaved PSO dynamics and solution diversity and local accuracy improvement by differential mutation.

II. MATHEMATICAL MODELING OF THE WIND FARM

One of the key objectives of (WT) location design is to reduce power loss caused by wake interferences among turbines. For an accurate estimation of these losses, a reliable wake model must be utilized. The Jensen model, originally introduced in [12], is among the most popular models in the literature. When wind hits a turbine, it decelerates and becomes turbulent and creates a wake, an area of decreased wind speed and heightened turbulence, directly downwind of the turbine.

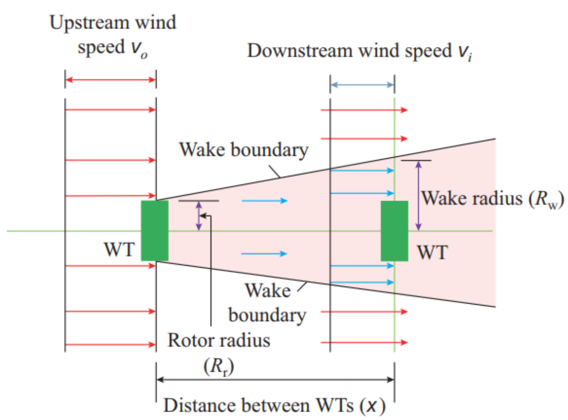

Fig. 1. Schematic diagram of the "Jensen" wake model.

The wake effect travels downstream and also moves sideways, impacting the functioning of downstream turbines. The "Jensen model", as shown in Fig. 1, assumes the wake to increase linearly with downstream distance from the WT and the wind speed profile within the wake to be flat across its cross-section. This is a simplification that makes it computationally inexpensive and therefore suitable for application to large-scale wind farm layout optimization problems. In this paper, the "Jensen model" is applied in the calculation of the wake velocity deficits, as a basis for the determination of the overall power production from the wind farm. Assuming that quantity of movement is preserved in the wake section, wind speed can be given as [13]:

$$v = v_0 \left[1 - \frac{2a}{\left(1 + \alpha \frac{x}{R_r}\right)} \right] \tag{1}$$

$$a = \frac{1 - \sqrt{1 - C_T}}{2} \tag{2}$$

$$R_{\rm r} = r\sqrt{\frac{1-a}{1-2a}} \tag{3}$$

$$\alpha = \frac{1/2}{\ln(\frac{H}{z_0})} \tag{4}$$

Here, v_0 represents the local wind speed that a turbine experiences when there's no intervention from any wakes. The variable x indicates how far downstream the turbine is located, while Rr refers to the rotor radius of the WT that's upstream, and R_w points to the expanded rotor radius of the wake at the downstream site. The tower height is symbolized as H, while α is the entrainment constant, that helps define how quickly the wake expands. The axial induction factor, a, shows how much the wind speed falls due to energy being extracted from the rotor. Additionally, C_T is the thrust coefficient, which measures the force the wind applies on the turbine rotor, and z_0 denotes the surface roughness of the ground in the wind farm area. When a WT is influenced by many upstream wakes, calculating the resulting wake velocity is not as straightforward as just adding them up. Instead, it is generally accepted that the total kinetic energy deficit at the downstream turbine is equal to the sum of the single energy deficits from each wake. Therefore, the effective wind speed that the i^{th} turbine, situated downstream of N_T turbines, experiences is determined by adding up these energy losses accordingly as:

$$v_i = v_0\left[1-\sqrt{\sum_{j=1}^{N_T}\left(1-\frac{v_{ij}}{v_0}\right)^2}\right] \tag{5}$$

The variable v_{ij} refers to the wind speed which the i^{th} WT encounters, impacted by the wake shaped by the j^{th} WT. In the linear wake model, we assume that this wake spreads out in a conical shape as it travels downstream. The area affected by this wake is defined by the wake influence radius, which indicates how far the wake's impact reaches. This radius is calculated using a specific formula that takes into account the distance between the WTs and the wake decay constant as:

$$R_w = R_{\rm r} + \alpha x \tag{6}$$

[6] introduced a basic economic model for WFLO. Within the model, the total cost mainly relies on the quantity of WTs installed. They normalized the annualized cost of a single turbine to a unit, which makes comparison more easily performed. To account for economies of scale, they presented a cost reduction factor that can provide a reduction of up to 1/3 in unit costs when more WTs are added. This is based on the idea that larger setups incur less per-unit infrastructure and maintenance costs. Therefore, the total cost for a wind farm with N turbines can be written as:

$$Cost_{Tot} = N(\frac{2}{3}+\frac{1}{3}e^{-0.00174N^2}) \tag{7}$$

The data relating to the WT and the wind farm are taken out from [6], [7] and are tabulated in Table 1.

Table 1. Windfarm data

Parameter	Symbol	Value
Tower height	H	60m
Rotor diameter	2r	40m
Wind Farm Surface Roughness	z_0	0.30m
Rotor performance efficiency	C_P	0.40
Air density	ρ	1.225kg/m^3
Thrust coefficient	C_T	0.88

Power output from a WT i, measured in kW, can be given as follows:

$$P_i = 0.5\,\rho\,\pi\,r^2\,v_i^3\,C_P/1000 \tag{8}$$

Where P_i is the total power output achieved considering wake effect in wind farm, that can be computed according to Table I, the approximation of equation (8) can give equation (9):

$$P_i = 0.3v_i^3 \tag{9}$$

In this paper, equation (9) is considered for power output calculations for comparing with previous results. For N WT, the total power output is given by the following expression:

$$P_{Tot} = \sum_{k=0}^{360} \sum_{i=1}^{N} \pi_j P_i(v_i) \tag{10}$$

Where π_j is wind probability which relates to the wind speed with a certain direction and $\sum_{j=0}^{360} \pi_j = 1$. The present power production from turbine i as a function of its wind speed v_i is P_i. Consequently, the objective function can be stated as:

$$minF = \frac{Cost_{Tot}}{P_{Tot}} \tag{11}$$

Where the objective function is the quotient of the total cost to the total power. Windfarm efficiency η can be calculated as follow:

$$\eta = \frac{\sum_{k=0}^{360} \sum_{i=1}^{N} \pi_j P_i(v_i)}{\sum_{k=0}^{360} \sum_{i=1}^{N} \pi_j P_{i,max}(v_{i,max})} \tag{12}$$

Under this framework, $P_{i,\max}$ represents, assuming no reduction from wake-induced flow deficits, the theoretical peak power output of turbine i at its maximum wind speed $v_{i,max}$.

III. OPTIMIZATION ALGORITHM

Particle Swarm Optimization (PSO) description: PSO is an evolutionary computation method inspired by the collective behavior of social organisms. This technique relies on how individual agents make decisions based on two key sources of information. The first is personal experience, each agent evaluates the choices it has previously made, identifying which option has yielded the most favorable outcome and how beneficial it was. The second source of information comes from the experiences of neighboring agents. That is, each agent observes and learns from the performance of others, recognizing which choices have led to optimal results within the swarm and how effective those solutions have been.

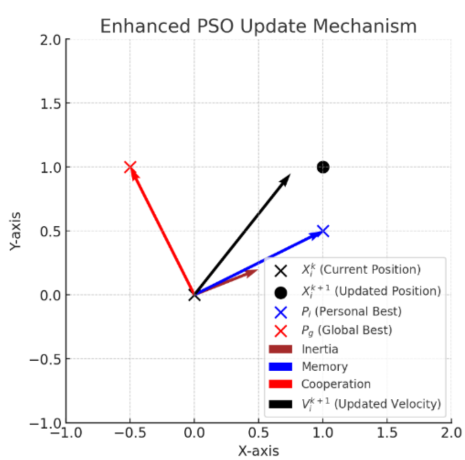

Fig. 2. Enhanced PSO velocity and position update mechanism.

Fig. 2 shows how a particle in the enhanced PSO algorithm updates its position. The new velocity (black arrow) is computed by merging three components: inertia (gray), memory of the particle's own best position (blue), and cooperation with the global best position found by the intelligence swarm (red). The particle travels from its actual position (black x) to a new position (black dot), directed by the present updated velocity. This mechanism can help balance survey and convergence in the optimization course. The complete and detailed description of the algorithm can be found in [15], [16]. As is usual in classical PSO models, each particle's state in the Quantum-behaved Particle Swarm Optimization (QPSO) framework is characterized by a wave function rather than by explicit spatial and velocity vectors. This quantum representation brings a fundamentally new dynamic whereby the exact position and velocity of a particle cannot be simultaneously found. Rather, what is known is the location's probability distribution based on the squared wave function $|\Psi|^2$. The possible terrain the particle lives in shapes this probability density. A QPSO algorithm for WFLO problem is proposed.

$$x_{i,j}^{t+1} = \Omega_{i,j}^{t} \pm \beta \, |M_j^t - x_{i,j}^t| \ln(\tfrac{1}{u}) \text{ and } M_j^t = (1/m) \sum_{i=1}^{m} P_{best,ij}^{t} \tag{13}$$

Here, u is a random number in the interval (0,1) chosen from a uniform distribution. M presents the mean best position, calculated as the average of the personal best P_{best} locations of all particles. The sole parameter in QPSO is the contraction expansion factor β, which adjusts the behavior of the convergence of the algorithm and is typically fixed to a value not more than 1.7 for performance and stability [15], [16]. Due to its effectiveness and simplicity of implementation, QPSO has been successfully applied across a series of standard optimization problems with notable results. The general pseudocode structure of the QPSO algorithm is presented below:

---

1. *Initialize a swarm of particles with random positions in the search space.*
2. *For each particle in the swarm:*
   a. Evaluate its fitness using the objective function.
   *b. Set the particle's personal best position (*Pbest*) to its current position.*
3. *Determine the global best position (Gbest) among all particles.*
4. *Repeat until the termination criterion is satisfied:*
   a. For each particle:
      i. Compute the local attractor point using the current Pbest and Gbest.
      ii. Calculate the mean best position (Mbest) from all Pbest values.
      iii. Generate a new particle position using the QPSO update equation derived from the quantum behavior of the particles.
      iv. Evaluate the fitness at the new position.
      v. If the new position improves the particle's Pbest, update its Pbest.
   b. Update Gbest if a new Pbest surpasses the current Gbest.

IV. CASE STUDIES, SIMULATION RESULTS AND DISCUSSION

The simulation is carried out on "Intel Core" (TM) i7 CPU@3.6GHz and 12GB of RAM and run the algorithm on the MATLAB averment in 14.08 seconds for the case 1, 479.64 seconds for case 2 and 618.25 seconds for case 3. The execution time is relatively long following the discretization of the wind direction into 36 sectors, so the algorithm consists of performing a calculation for the 36 wind directions. Several case studies carried out in [6] and [7] with a wind farm zone of 2kmx2km equally splitted to 100 squares with the centre of any cell is able to lodge one WT. This paper analyses three cases that are presented as follows:

A. CASE 1: (FIXED WIND SPEED AND FIXED WIND DIRECTION)

Under this scenario, wind direction and speed stay constant. Extending the analytical work of [7], the best arrangement was first found for a single column of 10 turbine sites orientated with the dominant wind. Once the best arrangement for that column was found, it was replicated to create a three-column array with one column at the center and identical columns at each boundary so extending the ideal pattern over the wind farm. [7] analytically determined the optimal wind turbine configuration by starting with a single column of 10 turbines in the direction of the prevailing wind. They worked their way up from this configuration to fit two additional columns, one on each side of the original column, in a symmetrical three-column formation. The larger configuration was verified to confirm it continued with the aerodynamic advantages achieved in the original single-column configuration. This case follows a configuration almost similar to that reported in [7] and have further been validated by [14] as shown in Fig. 4(a).

B. Case 2: (Fixed wind speed with Intermittent wind direction)

In this case, we consider a consistent wind speed of 12 m/s that equally may come from any direction. The complete 360° compass is split into 36 segments of 10° each, with the wind direction in each sector treated as having a same likelihood of occurrence, therefore capturing this fluctuation. Under this hypothesis, the spacing between WTs becomes a critical factor effecting wake losses and, therefore, the total power generation of the wind farm. In prior work, [17] used a Binary Particle Swarm Optimization algorithm with Time-Varying Acceleration Coefficients (BPSO-TVAC), which proved an improved performance of the fitness function. The optimized arrangement achieved employing this methodology closely look like the arrangement proposed by [7], as shown in Fig. 4(b). Although the enhancement in the objective function was modest, the refined turbine layout led to a clear increase in total power output, reflecting a more efficient using of the available space.

C. Case 3: (Intermittent wind speed with Intermittent wind direction)

This reflects a more complex and advanced WFLO problem, where wind speed and direction are both intermittent parameters. Following the method used by [7], three representative wind speeds of 8 m/s, 12 m/s, and 17 m/s are selected in order to facilitate comparison. Wind direction is subdivided into 36 intervals, each spanning 10 degrees, as in the first case. The reference direction (0°) is synonymous with a wind from the north, and values rise in a clockwise manner, so 90° is an easterly and 270° a westerly wind.

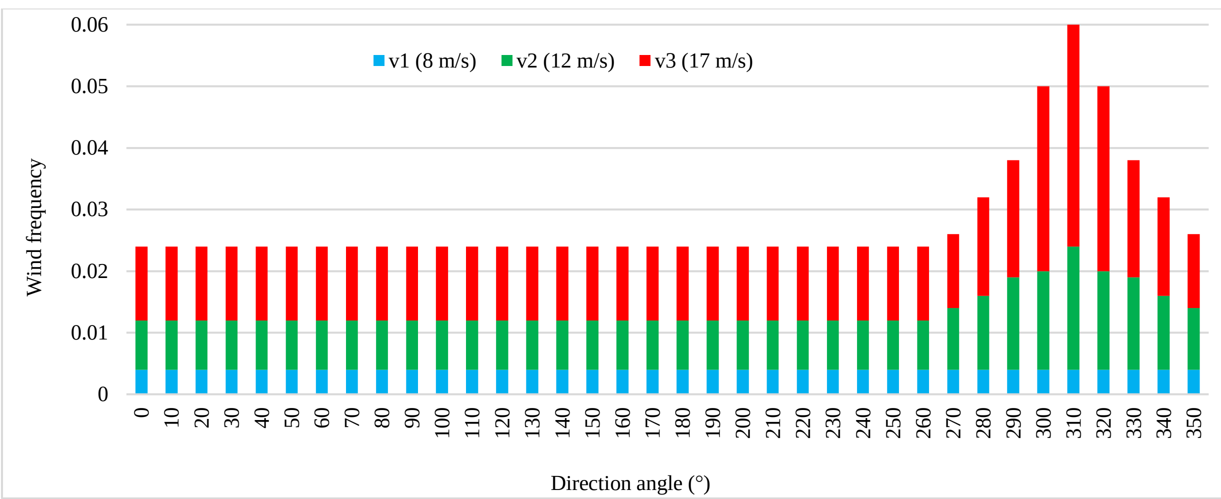

Fig. 3. Wind probability distribution - Case 3.

The wind resource characteristics for this example are shown in Fig. 3, which is the joint probability distribution of wind speed and direction. This distribution assigns a probability to each wind speed–direction combination, with the total of all probabilities equal to one. The ideal layout created by the QPSO algorithm proposed here with the same number of WT as in the initial study by [7] is shown in Fig. 4(c).

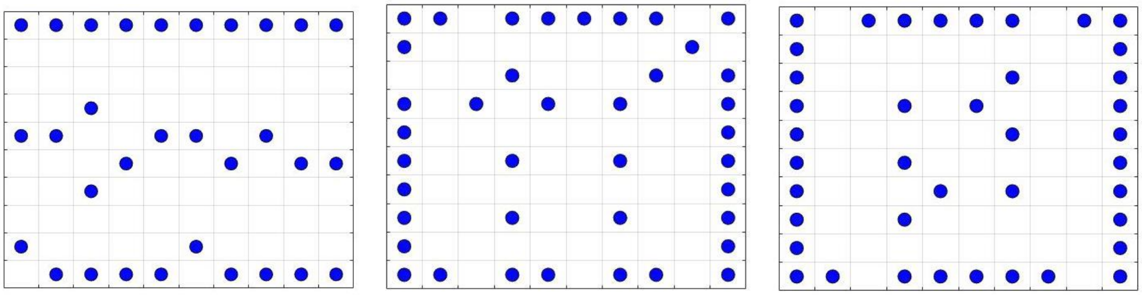

Fig. 4. Optimal windfarm configurations – (a) Case 1, (b) Case 2, (c) Case 3. (The blue dot show the location of WT)

The objective function, power and efficiency of the wind farm location, was re-computed with a similar power model and probability distribution of the wind, according to the procedure described in [7]. The results of these calculations are presented in Table 2. In comparison with the result of [7], the new arrangement has a smaller fitness value, meaning a better design, more efficiency, and greater overall power output.

Table 2. Results of different cases

# Case	Number of turbines	Power (kW)	Windfarm Efficiency (%)	Fitness function (x 10^{-4})
Case 1	30	14273.94	91.782	15.5147
Case 2	39	17585.67	86.982	15.4845
Case 3	39	32301.22	87.846	8.3345

Fig. 5 shows the convergence curve of the proposed algorithm for the Case 1, displaying how the fitness function gradually enhances over successive generations until it achieves an optimal and stable solution.

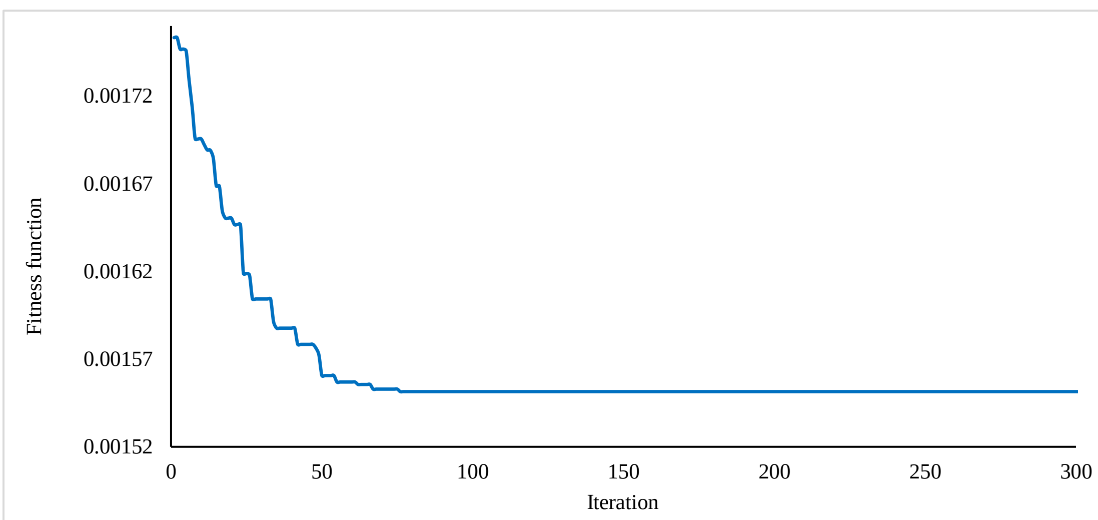

Fig. 5. Convergence curve of the proposed algorithm for the case 1.

V. CONCLUSION

This paper introduces a new methodology for the problem of WFLO using QPSO algorithm considering different cases both wind speed and wind direction. The optimum arrangements of WTs obtained using the proposed approach are more efficient, thereby producing high output power. Nevertheless, the findings introduced in this paper prove that the proposed QPSO algorithm offers a highly operative and best solution for WFLO problem, outperforming various prior works in terms of output efficiency and performance. Moreover, the objective function and cost model used in this paper are designed to equilibrium efficiency with economic viability. However, this trade-off highlights a limitation that future work should be addressed more comprehensively. Finally, to confirm the real world applicability of the proposed WT arrangement, further surveys including more practical models of wind variability and uncertainty are recommended.

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TUESDAY OCTOBER 28, 2025

Auditorium

8h00		RECEPTION & REGISTRATION
8H30		OPENING CEREMONY Representative of Ibn Badis University of Mostaganem Representative of the Faculty of Science and Technology Representative of the local authorities Representative of Conference Organizers
CAP-HYPROC Auditorium		KEYNOTE SPEAKERS **Moderator** **Prof. Cherif BENOUDJAFER (Univ. Bechar)**
09H00		Dr. Abdallah KHELLAF CDER, Bouzaréah, Alger. ALGERIA Overview of artificial intelligence applications in hydrogen chain value 
09H45		Pr. Adel MELLIT Seddik Benyahia University, Jijel. ALGERIA The role of artificial intelligence in advancing the solar energy sector: Bridging the gap between academic research and industry 
10H30 – 11H00		COFFEE BREAK offered by FST-Mostaganem
12H15		Dr. Benameur NEHAR Abou Bekr Belkaid University, Tlemcen. ALGERIA Cultivating Global and Smart Citizenship through Virtual Exchange on the UN SDGs in Higher Education 
Online 01H00		Dr. Gokul PANDY IEEE-SM, Richmond section chair, USA meet.google.com/mrf-syzy-hch Revolutionizing Client Service Agreements: Selenium-Driven Open-Source Robotics Process Automation 
11H00 **12H00**		POSTER SESSION-1- CAP-HYPROC Hall **Moderators: Prof. Youcef SOUFI (Univ. Tebessa); Mr. Kheireddine MERHOUM (UMBB)**
		AI-Based Optimization and Control Systems **Prof. Abdelghani AISSAOUI (Univ. Bechar); Dr. Abdelkader HADJ DIDA (ASAL-Oran)**
11H00	**22**	- Souad TAHRAOUI *AI-Powered Fault Diagnosis in Dynamic Systems with Tornado Algorithm Optimization*
11H10	**29**	- Azeddine BELOUFA *PSO-Optimized High-Gain Observer-Based Backstepping Control for TRMS Trajectory Tracking*
11H20	**191**	- Fatima Zohra MEDJAOUI *Experimental Validation of a Square Planar Micro-Coil Model*

11H30	**218**	- Nawres BOUAM *Optimization of Robotic Navigation for Safety and Efficiency in the Oil and Gas Industry Using the A* Algorithm*
11H40	**149**	- Soumia TOUAMI *Control of Brushless Doubly-Fed Generator BDFIM using Neuro-fuzzy Controllers*

Photovoltaic Systems and MPPT Techniques

Prof. Abdelghani HARRAG (Univ. Setif); Dr. Fatima BOUTLILIS (Univ. Mostaganem)

11H00	**106**	- Amel ABBADI *Enhanced Accuracy in Estimating PEM Fuel Cell Parameters Using the Walrus Optimization Algorithm*
11H10	**216**	Yamina BELGAID *Optimal tuning of a PI controller using the Particle Swarm Optimization (PSO) algorithm for wind turbine applications*
11H20	**147**	- Khadidja DERBALI *Optimization of the Solar Cell Double Diode Model Estimation Using the Dung Beetle and Arctic Puffin Optimizers with Lambert-W Function and Newton-Raphson Methods*
11H30	**134**	- Fethia HAMIDIA *Enhanced MPPT Algorithms for PV Panels: Review and Comparative Analysis*
11H40	**188**	- Fatima SALHI *A Comparative Analysis of MPPT Techniques for Grid Connected PV System*
11H50	**209**	- Fatima SALHI *Photovoltaic Pumping System Based On MPPT-DNN*
12H00	**194**	- Mokhtaria DERKAOUI *Stand Alone Photovoltaic Module with an Integrated On-Chip Circular Spiral Inductor*

Power Electronics and Advanced Converters

Prof. Mouloud DENAI (ESGEE-Oran) ; Dr. Fethi AKEL (UDES-CDER)

11H00	**183**	- Oqeyl DJEBOURI *A Performance Analysis of a High-Gain three Phase Interleaved Boost Converter with Switched Capacitor Network for Photovoltaic Systems under Different Environmental Conditions*
11H10	**132**	- Brahim LACHI *Direct Torque Control (DTC) of a Synchronous Drive Using a Three-Level NPC Inverter in an Electric Traction Application*
11H20	**150**	- Abdelkader RABAH *A Novel Method for Inverter Open-Circuit Fault Diagnosis Using Improved Variational Mode Decomposition*
11H30	**116**	- Oqeyl DJEBOURI *A Comparative Evaluation of Metaheuristic Algorithm Using Two Different Simulation Current Calculation Methods for Extracting Photovoltaic Single-Diode Model Parameters*
11H40	**138**	- Kada BECHAREF *Development of a Compact Wideband Bandpass Filter Incorporating Complementary Interdigital Resonator E (CIRE) on a Half-Mode Substrate Integrated Waveguide Coupled with Corrugated Structures*

13H30-14H30 POSTER SESSION -2- CAP-HYPROC Hall

Moderators: Prof. Youcef SOUFI (Univ. Tebessa); Mr. Kheireddine MERHOUM (UMBB)

Hybrid Energy Systems and Storage Technologies

Dr. Rafika BOUDRIES (CDER Bouzareah); Dr. Missoum IBRAHIM (Univ. Mostaganem)

13H30	**42**	- M'hamed SEKOUR *Energy Management in a Hybrid Fuel Cell–Battery–Supercapacitor System for Drone*
13H40	**130**	- Abdeldjalil DAHBI *An Experimental Study of a Stand-alone Hybrid system installed in Adrar*
13H50	**172**	- Henia FRAOUCENE *Effect of Rectifier load resistance on the RF received Wake-up Signal at 2.45 GHz*
14H00	**220**	- Abdallah BOUAM *Experimental Feasibility Study of a Cogeneration System Based on the Coupling of a Vortex Tower and NPP Cooling System for Sustainable Energy Production*

14H10	**7**	- Rachid KHELFAOUI *Smart Control and Energy Optimization of a Solar-Driven Absorption Cooling System in Béchar (Algerian Sahara)*
		Smart Agriculture and IoT Applications **Prof. Baghdad HADRI (Univ. Mostaganem) Prof. Saliha AREZKI (USTHB Algiers)**
13H30	**49**	- Zoubir BELGROUN *Development of an ontology-based solution to agricultural semantics*
13H40	**50**	- Zoubir BELGROUN *A Smart Solution for Monitoring Greenhouses Utilizing the Internet of Things*
13H50	**101**	- Mouloud TIZZAOUI *Design Considerations for a Stand-Alone PV-Powered Evaporative Cooling of Greenhouse in the Saharan Environment*
14H00	**27**	Ali BOUZIANE *Clean Combustion Modeling of Premixed DME Flames with LES: A Step Toward RCCI-Compatible Fuels for Green Mobility*
14H10	**204**	- Tewfik LAMRANI *Advancements and Challenges in Multimodal RFID Sensors: From Industrial IoT to Smart Applications*
14H20	**165**	- Mokrane MEHDI *Enhancing Energy Efficiency in Domestic Refrigerators: Experimental and Statistical Evaluation of Phase Change Material Integration*
		Energy Forecasting and Predictive Maintenance **Prof. Mohamed Arezki MELLAL (Univ. Boumerdes) Dr Mohamed BENZIDANE (Univ. Mostaganem)**
13H30	**222**	- Dalila CHERIFI *Predictive Maintenance of Wind Turbines Using Machine Learning: Addressing Fault Detection with SCADA Data*
13H40	**155**	- Walid BOUKERNE *Study and Implementation of an End-to-End OFDM-Based Data Transmission System Using SDR*
13H50	**113**	- Kacem GAIRAA *Intra-Hour Solar Irradiance Forecasting Based on Feature Selection Techniques*
14H00	**159**	- Lamia MAY *A Dynamic Stress-Reset Model for maintenance Optimization Integrating Physics-Informed Fatigue Accumulation and Resource-Aware Intervention Efficiency*
14H10	**196**	- Abderrahmane KHELFAOUI *Solar Declination Measurement Test and Comparison with Declination Tables and Theoretical Methods*
		Thermal Systems and Advanced Energy Technologies **Dr. Mohamed AYAD (UDES); Dr. Slimane SOUAG (Univ. Mostaganem)**
13H30	**181**	- Amina Lyria DEGHAL *Numerical and Analytical Study of the Influence of Geometrical Parameters on the Performance of a Vortex-Type Cooling Tower*
13H40	**219**	- Amel DADDA *Influence of Chimney Geometry on Coriolis Force Generation in a Vortex Tower Prototype*
13H50	**186**	- Ridha ALLICHE *Dimensionless Analysis and Correlation of Nusselt Number in a Regenerator-Free LTD Stirling Engine*
14H00	**127**	- Kheira BELHAMIDECHE *The effect of heat transfer fluid flow rate and heat exchanger installation depth on the performance of low enthalpy geothermal energy*
14H10	**109**	- Abdellah MEKEDEME *Modeling and Simulation of Herschel-Bulkley Drilling Fluids in Vertical Boreholes with Rotating Bits*
14H30 – 15H30		LUNCH

REMOTE SESSION

ROOM A-1-28		Dr. Akshay SHARMA (SM-IEEE); Dr. Hadj Larbi BEKALOUZ (Univ. Mostaganem) :: meet.google.com/mrf-syzy-hch
15H30	33	-Hamza BENYEZZA IoT-Based Platform for Monitoring and Managing Fuel Delivery Trucks
15H45	58	- Ahmed BOURAIOU Design of Sustainable IoT-Based Weather Monitoring
16H00	85	- Lynda OUZANE *Design and simulation of a smart energy meter for real time monitoring*
16H15	96	- Faycal BENYAMINA *Enhanced LVRT Control of Grid-Tied Inverters under Unbalanced Grid Faults Using Notch Filter-based Sequence Extraction*
16H30	137	- Halima MAHIDEB *Indoor and Outdoor Air Quality Monitoring with IoT-AI Technologies: Current State and Integration Challenges*
ROOM B-1-28		Prof. Amel ABBADI (Univ. Medea); Dr. Sakina ATOUI (UDES-CDER) :: meet.google.com/nzt-jvxh-icq
15H30	60	- Mustapha MEROUAH Enhanced MPPT in PV Systems Using k-Nearest Neighbors and Integral Backstepping Control
15H45	64	- Hizia ABED Real time identification of the parameters of a photovoltaic panel by ant colony optimization in the continuous domain
16H00	94	- Ryma LEBIED Robust Solar System with Different advances techniques
16H15	98	- Samah BOUAROUDJ Novel High Efficiency ZCS DC/DC Interleaved Boost Converter For Photovoltaic Solar System
16H30	206	- Alla Eddine TOUBAL MAAMAR A simple and accurate script to simulate solar panel models at variable environmental conditions of temperature and irradiation
ROOM A-2-28		Prof. Lamia HAMZA (Univ. Bejaia); Dr. Anup KAGALKAR (SM-IEEE) :: meet.google.com/mrf-syzy-hch
17H00	25	- Amina MAZIGHI *Innovation in infiltration estimation: From empirical model to AI-based solutions*
17H15	37	- Sonia BAAZIZ *AI-Assisted Design and Characterization of a Novel Cytosine-Based Hybrid Material for Renewable Energy Applications*
17H30	76	- Abdesselem BEGHRICHE *AI-Driven Smart Management and Optimization of Green Hydrogen Production in Renewable Energy Grids Using Bio-Inspired Algorithms and Edge Computing*
17H45	158	- Sara OUARTI *A Hybrid Deep Learning Approach for Anomaly Detection in Smart Grid Systems*
18H00	199	- Mohamed ADAIKA *Intelligent Fault Detection in Transformer Magnetic Oil Level Indicators Using Machine Learning for Smart Renewable Grids*
ROOM B-2-28		Prof. Fethia HAMIDIA (Univ. Medea); Dr. Nouamen KELLIL (UDES-CDER) :: meet.google.com/nzt-jvxh-icq
17H00	43	- Mokhtar Mahmoud MOHAMMEDI *SMO Speed Sensorless Fault Assessment Technique Based on DFIG-WECS*
17H15	104	- Mourad NAIDJI *A Novel Nature-Inspired Approach for Wind Farm Location Optimization Considering Wake Effects*
17H30	115	- Hadjira MECHRI *Efficient Wind Energy Extraction and Fault Detection in a PMSG-Based WECS with NPC Inverter*
17H45	153	- Lakhdar SAIHI *Fuzzy Logic Control of Variable-Speed Wind Turbine Base on DFIG*
18H00	92	- Samira HADIBI *Impact of System Complexity on the Nonlinear Dynamics of Coupled Axial-Torsional Drilling Models*
COFFEE BREAK		

WEDNESDAY OCTOBER 29, 2025

RooM A		**INTERNET OF THINGS ::** meet.google.com/mrf-syzy-hch **Prof. Abdellah CHAOUCH (Univ. Mostaganem); Dr. Fatiha BECHIRI (Univ. Mostaganem)**
08H00	**162**	- Rafika BOUDRIES *Methanation of CO_2 Removed From Raw Natural Gas for Smart Urban Centers in the In-Salah Region*
08H20	**74**	- Ibtissam CHEKKAL *Artificial Intelligence Applications for Indoor Thermal Comfort in Residential Buildings: A Scoping Review of Early Design Methods*
08H40	**17**	- Farouk BENAHMED *Home Monitoring System using IoT and Deep Learning model*
09H00	**177**	- Imane YAHIAOUI *State of Health Estimation of Lithium-Ion Batteries in Electric Vehicles*
RooM B		**ELECTRICAL VEHICLE & CONTROL ::** meet.google.com/nzt-jvxh-icq **Prof. Emrt Fateh KRIM (Univ. Setif); Dr. Mansour ABED (Univ. Mostaganem)**
08H00	**81**	- Abdelmoumene TOUABI *A Concise Survey on Neural Networks Compression Techniques*
08H20	**175**	- Chahrazad BENGANA *AI-Based Fault Detection for PDC Bit Wear Monitoring Using Random Forest Classification*
08H40	**135**	- Sarah Kawther SEDJAR *Intelligent Optimization and Modeling of Miniaturized Photovoltaic Cells for Embedded Applications using Hybrid AI Techniques*
09H00	**14**	- Fatna LAZGHEM *Artificial intelligence and plant disease detection: A critical analysis of advances, challenges and strategies for resilient agriculture*
RooM A		**GRID-CONNECTED CONTROL SYSTEMS::** meet.google.com/mrf-syzy-hch **Prof. Katia KOUZI (Univ. Laghouat) ; Dr. Saliha REZINI (Univ. Mostaganem)**
09H30	**110**	- Oussama HARROUZ *Short-Term PV Power Forecasting Using LSTM: A Case Study of grid-connected PV system in Adrar City*
09H50	**213**	- Amira LAGHOUATI *A Novel Method for Cost-Effective Green Hydrogen Production Using Sound Wave-Assisted Electrolysis*
10H10	**161**	- Fayçal Hadj Mihoub SIDI MOUSSA *Modeling and Control of a Grid-Connected Hybrid Wind-Photovoltaic System with a PMSG-Based Wind Turbine and PSO-MPPT Algorithm for the PV Array*
10H30	**65**	- Toufik TRIF *Photovoltaic and Wind Power Forecasting Using LSTM Networks with Adaptive Hyperparameter Tuning*
RooM B		**ENERGY MANAGEMENT & MATERIALS in RENEWABLES ::** meet.google.com/nzt-jvxh-icq **Dr. Merzak FERROUKHI (USTHB, Algiers) ; Dr. Saadiya BENATMANE (Univ. Mostaganem)**
09H30	**128**	- Idriss Hadj MAHAMMED *Estimating Power Outputs of Thin Film CIS PV Modules Using Neuronal Approach: A case Study in Arid Environment*
09H50	**152**	- Walid REZIG *Biomass Diatomite-Supported Ferrihydrite Silicide Hybrid Granule Catalyst TiO2: Synthesis and Evaluation for Photocatalytic Dye Removal*
10H10	**19**	- Abdelkarim CHERHABIL *Metaheuristic Approaches for Medical Image Denoising*
10H30	**129**	- Ayoub MEGHEBBAR *When Machines Speak Human: Detecting Computer Generated Reviews Using Transformer Models*
10H50	**13**	- Nadir MAHAMMED *Fake no More: Smarter Social Media Detection With RTGBO*
		COFFEE BREAK

RooM A		**SMART ENERGY MANAGEMENT & IoT ::** meet.google.com/mrf-syzy-hch **Prof. Adel MELLIT (Univ. Jijel); Dr. Leila GHOMRI (Univ. Mostaganem)**
11H30	**221**	- Saliha AREZKI *Hybrid Simulation-Experimental Framework for Dynamic PV Reconfiguration in Agricultural Applications with Real-Time IoT Supervision*
11H50	**68**	- Abderrahmane HALLOUI *A Review on Optimized Task Offloading Strategies in Fog Computing and IoT*
12H10	**87**	- Mohammed BEKHTI *Comparative Techno-economic and environmental performance of Standalone hybrid energy systems for Telecommunications Towers: A Case study of the African Unity Road in Southern Algeria*
12H30	**141**	- Mansour BENDREF *AI-Driven Real-Time Adaptive Beam Steering for 5G Fixed Wireless Access Antenna Systems*
RooM B		**ELECTRICAL NETWORK CONTROL ::** meet.google.com/nzt-jvxh-icq **Prof. Benaissa BEKKOUCHE (Univ Mostaganem); Prof. Cherif BENOUDJAFER (Univ. Bechar)**
11H30	**54**	- Seif Elislam CHELLI *Proportional resonance controller versus PI controller performances of PWM controlled rectifier connected to an unbalanced three-phase grid voltages*
11H50	**11**	- Zana KARI *The Interest of Shielding for Integrated Inductance*
12H10	**59**	- Abdelhak FLIH *HVDC fault location using Artificial Neural Network method*
12H30	**117**	- Samia SAIB *Improvement of the performance of the electrical network by the integration of FACTS devices*
12H50	**131**	- Tahani nor el Houda TSRIAT *Performance Analysis of Adaptive P&O, ANN and PSO Based MPPT Algorithms for Photovoltaic Systems*
13H00 – 14H00		LUNCH
RooM A		**STORAGE and ELECTRICAL VEHICLE ::** meet.google.com/mrf-syzy-hch **Prof. Hadj Adda BENTOUNES (Univ. Mostaganem); Prof. Mohamed Arezki MELLAL (UMBB)**
14H00	**139**	- Bouziane BOUSSAHOUA *A New Priority List Algorithm for power system unit commitment problem solution*
14H20	**182**	- Aissa HAMLAT *Advanced Non-Linear Control Designed for Fuel Cell/Super-Capacitor Hybrid Electric vehicle*
14H40	**212**	- Houaria NEDDAR *Towards a Decarbonized Life: Impact of Fuel Cell Performance Parameters*
15H00	**123**	- Wiame GUENAYA *Evaluating The Performance of NMC and NCA Battery Technologies for Electric Vehic*
15H20	**223**	- Salim DJAHFA *Estimating parameters values of battery lead-acid using Simulink Design Optimization*
RooM B		**ENERGY MANAGEMENT & MICROGRIDS ::** meet.google.com/nzt-jvxh-icq **Prof. Mostefa RAHLI (USTO); Dr. Khadidja BERADJA (Univ. Mostaganem)**
14H00	**168**	- Zohra OUCHIHA *Effect of EGV cluster on working 2-blade Savonius rotor*
14H20	**154**	- Randa BENKHELIFA *Adaptive Preprocessing for Improving Early Detection and Classification of Anomalies on Photovoltaic Panels*
14H40	**89**	- Djamel SELKIM *Optimal Power Management and Control of Islanded Microgrid to Prevent Under-Frequency Load Shedding During Load Variations*
15H00	**133**	-Hadj Abderrahim MEBARKI *Space Vector Modulation Control of a Three-Level NPC Inverter*
15H20	**184**	- Ahmed DAHIA *Numerical study of the behavior of air flow circulation through Novel Vortex Tower Prototype using CFD code*

15H40	**192**	- Fatna BAHLOULI *Heat Dissipation Strategies for Planar Inductive Components*
COFFEE BREAK		
THURSDAY 30 OCTOBER 2024		
Welcome COFFEE & TEA		
RooM A-1-30		**Intelligent Control Systems for Renewable Energy::** meet.google.com/mrf-syzy-hch **Dr. Kheyreddine DJOUZI (UMBB) ; Dr. Aoued MEHARRAR (Univ. Tissemssilt)**
9H00	**88**	- Kheira MENDAZ *Artificial Neural Proportional Integral control Wind Turbine Based Doubly Fed Induction Generator*
9H15	**32**	- Nesrine NESRINE *Dual-Loop Control Strategy for a Standalone PV Boost Converter Using PSO-Tuned PI and Model Predictive Current Control*
9H30	**148**	- Mohammed Kabir BOUMEGOUAS *Robust Nonlinear Control for Buck-Boost Converter Using Sliding Mode Control For Battery Storage System of Electric Vehicle*
9H45	**121**	- Amina Dounia BABOU *Genetic Algorithm Enhanced Backstepping for Real-time Trajectory Tracking of a Twin Rotor MIMO System*
10H00	**151**	- Habiba HOUARI *Advancing PID Control Quarter-Car Suspension System with Metaheuristic Optimization Comparative Study*
RooM B-1-30		**AI-Based Fault Detection and Diagnostic Systems::** meet.google.com/nzt-jvxh-icq **Dr. Bhushan B. CHAUDHARI (IEEE-SM, India); Dr. A. TAMILSARAN (India)**
9H00	**40**	- Fatima Zohra BOUDJELLA *Hybrid Approach for DGA Diagnosis of Transformers: Comparison of Supervised Classifiers with Advanced Preprocessing*
9H15	**83**	-M. ALLAM *Intelligent Control of a doubly fed induction generator for wind energy conversion systems in variable speed*
9H30	**70**	- Abderrahmene MOKHTARI *Neural Network Sliding Mode Observer Based Fault diagnosis for Wind Turbine Benchmark Model*
9H45	**173**	- Ahmed DJERBOUB *Intelligent Fault-Tolerant Control for Boost Converter IGBT Failures Using SVM within PV-Integrated Four-Leg SAPF Systems*
10H00	**197**	- Mohamed ADAIKA *Deep Learning-Based Detection of Environmental Faults in Photovoltaic Systems under Dust and Humidity Conditions*
RooM C-1-30		**Electric Vehicles and Advanced Motor Drives::** meet.google.com/siz-ewma-buv **Prof. Mounir BOUHEDDA (Univ. Medea); Dr. Ahmed MEDIANI (CDER)**
9H00	**4**	- Nawal TOUHAMI *Classification of Electric Vehicles: A Comprehensive Overview*
9H15	**28**	- Norediene AOUADJ *Independent Control with MTPA-DTC of Five-leg inverter-dual IPMSM motors powertrain used in Vehicle propulsion system*
9H30	**52**	- Norediene AOUADJ *Enhanced Direct Torque Control of PMSM Drives for Electric Traction Systems: A Comparative Study Between Classical DTC and a Hybrid Fuzzy Logic–SVM Approach*
9H45	**71**	- Mohamed MILOUDI *AI-Driven EMI Analysis and Experimental Measurement in DC Motor Drives: Comparative Study of Chopper Topologies for Enhanced Electromagnetic Compatibility*
10H00	**75**	- Justin MOSKOLAI NGOSSAHA *Next-Generation Urban Mobility for Developing Countries:AI-Supported Digital Twin Framework*

10H15	**102**	- Abdelkader MERAH *Finite-Horizon LQR and Kalman Estimator Design for Robust Lateral Dynamics Control in Autonomous Driving*
COFFEE BREAK		
RooM A-2-30		**Smart Grid Systems and Power Quality::** meet.google.com/mrf-syzy-hch **Pr. Houaria NEDDAR (Univ. Mostaganem); Dr. Abdelhakim IDIR (Univ. M'sila)**
11H00	**12**	- Khadidja MEDJDOUBI *Study of a Hybrid UPQC with Intelligent Control*
11H15	**16**	- Khadidja MEDJDOUBI *Improving energy quality with renewable energy sources integrated into Algeria's southwest grid*
11H30	**111**	- Abderrezzaq ZIANE *Secure and Scalable Framework for Real-Time Net Metering in Smart Grids*
11H45	**178**	- Boubakar FARADJI *Comparative Study of Centralized and Decentralized Electrical Network Configurations for Equal Installed Power Capacity*
12H00	**142**	- Lakhder AYHAR *Comparative Study of Synchronization Techniques for Grid-Following Inverters*
RooM B-2-30		**IoT and Wearable Smart Systems::** meet.google.com/nzt-jvxh-icq **Dr. Satish KABADE (IEEE-SM, India); Dr. Meriem DJEZZAR (Univ. Khenchela)**
11H00	**62**	- Sabrina MEHDI *Internet of Wearable Things Systems: A Comprehensive Analysis of Development Challenges and Characteristics*
11H15	**169**	- Rania DJEHAICHE *Smart Environment Management Using Dual IoT/M2M Platforms*
11H30	**205**	- Adil BAKRI *Forest Fire Detection using Sensor Networks and Mobile Communication Systems*
11H45	**215**	- Adil BAKRI *A Wearable Smart Glasses Approach for Real-Time Driver Drowsiness and Fatigue Detection to Improve Road Safety*
12H00	**190**	- Ibrahim ALDREES *Giving a Voice: A Novel Approach Combining Visual and Product-based Applications to Sign Language Translation*
12H15	**125**	- Mohamed Ilyas RAHAL *Towards Smart Automation: An IoT-Integrated Control Strategy for Industry 4.0*
RooM C-2-30		**AI for Transportation and Autonomous Systems::** meet.google.com/siz-ewma-buv **Dr. Rajaganapathi Rangdale Srinivasa RAO (IEEE-M), India; Dr. Mokhtar ABBASSI (Tunisia)**
11H00	**9**	- Abdelkader MEKKAOUI *A New Differential Evolution-based Routing Protocol for Surveillance Drones in Urban Areas*
11H15	**55**	- Chaima AYACHI AMAR *Reinforcement Learning for Energy-Aware Vehicle Routing in Renewable-Powered Microgrid Systems*
11H30	**67**	- Fathi Rezzag AOUID *Robust Palmprint Authentication Using Curvature-Enhanced Bifurcation Coding*
11H45	**75**	- Justin MOSKOLAI NGOSSAHA *Next-Generation Urban Mobility for Developing Countries:AI-Supported Digital Twin Framework*
12H00	**179**	-Badia KLOUCHE *Artificial Intelligence-Based Approaches for Misinformation Detection: A Case Study of Ooredoo's Corporate Innovation Strategy*
12H15	**217**	- Abderrahmane TAMALI *A Myoelectric-Controlled 3D-Printed Prosthetic Arm: Design and Implementation*
RooM A-3-30		**Deep Learning for Energy Forecasting and Monitoring::** meet.google.com/mrf-syzy-hch **Prof. Younes CHIBA (Univ. Medea); Dr. Anup KAGALKAR (IEEE-SM), India;**
12H30	**157**	- Lamis SERRAT *Hourly Global Solar Irradiance Forecasting in a Desert Region Using a Deep Neural Model with Hybrid Inputs*

12H45	**195**	- Lydia TOUAHRI *An Empirical Attention-Based LSTM Approach for Weekly Sales Forecasting in an Agri-Food Firm*
13H00	**198**	- Mohamed ADAIKA *Intelligent Classification of Partial Shading in PV Systems Using LSTM and DNN Models: A Comparative Study*
13H15	**210**	- Amira RAMZI *AI-Based Crop Yield Classification from Satellite Imagery: Enhancing Agricultural Monitoring in Algeria*
13H30	**143**	- Meryem Mamia BENOSMAN *Enhanced RVNN-Based Digital Predistortion for Wideband Power Amplifiers with Memory Effects*
RooM B-3-30		**Hydrogen Production and Hybrid Energy Systems::** meet.google.com/nzt-jvxh-icq **Dr. Maria MALVONI (ENEA-Italia); Dr. Amine HARTANI (Univ. Adrar);**
12H30	**95**	- Cherif MESKINE *Design and MILP-Based Optimization of Hydrogen-Integrated Multi-Energy Microgrids: Case Study at IMT Mines Albi*
12H45	**112**	- Hani BELTAGY *Sizing and simulation of a hybrid Photovoltaic-Wind system for green hydrogen production*
13H00	**100**	- Elaid BOUCHETOB *Efficiency Analysis and Reliability Prediction of DC-DC Boost Converters for PV Application: Wide Band-Gap Devices*
13H15	**107**	- Boucif ZINA *Numerical Study of a Solar Air Heater Featuring a Corrugated Collector Plate*
13H30	**82**	-Salah Eddine ZIRAR *Control Strategy of a Wind Energy Conversion System Based on Five-phase Permanent-Magnet Synchronous Generator*
RooM C-3-30		**Advanced Materials and Wireless Communications ::** meet.google.com/siz-ewma-buv **Prof. Abdelkader BENABDELLAH (Univ. Tiaret); Dr. Abdellah REZOUG (UMBB)**
12H30	**47**	- Ghania DEKKICHE *Facile sonochemical synthesis and characterization of cobalt oxide nanoparticles in the presence of ionic liquid*
12H45	**164**	- Mayliss YOUSFI *Vulnerability Cost Hardening using Stochastic Games and K-means in VANET Environments*
13H00	**156**	- Abdelouahab BOURAIOU *Study of the influence of some parameters on the performances of a superconducting patch antenna*
13H15	**136**	- Khadidja RAHMOUNE *Control of grid-connected PV system associated with LCL filter for power production and power factor correction*
13H30	**63**	- Yamina BEKRI *New Simple and Accurate Closed-Form Expressions for the Electromagnetic Parameters of a Novel Quasi-TEM Cylindrical Coaxial Directional Coupler for High-Power Telecommunications Applications*
13H45	**66**	- Amel HAOUZI *Spectrum and Energy Efficiency for DL - NOMA Systems in Cognitive Radio/5G Networks*
14H00 – 15H00		LUNCH
08H00 To 13H45		WORKSHOP ***Prof. Dalila CHERIFI*** (IGEE, UMBB, Algeria) *Introduction to Machine Learning*
13H50		CLOSING CEREMONY