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Paper ID 22

Comparative Analysis of Pure ZnO, Ag-Mn Codoped ZnO, and Mn:ZnO/Ag/Mn:ZnO Multilayer Transparent Conductive Oxides for Photovoltaic Applications

Authors: Fouaz Lekoui (Centre de développement des technologies avancées)*; Khaoula Settara (University of Skikda); Rachid Amrani (University of Algiers 1); Elyes Garoudja (CDTA); Walid Filali (CDTA); Slimane Oussalah (CDTA); Driss Dergham (CDTA); Salim Hassani (CDTA)

Abstract

This study investigates the impact of multilayer structuring and co-doping on the optoelectronic properties of zinc oxide (ZnO) thin films. Pure ZnO, Ag-Mn co-doped ZnO, and Mn:ZnO/Ag/Mn:ZnO multilayered thin films were synthesized using the Rapid-Thermal-Evaporation (RTE) technique and deposited onto standard glass substrates. The structural characteristics were analyzed via X Ray Diffraction (XRD), while the optical and electrical properties were assessed using Ultraviolet-Visible spectrophotometry and the four-point probe method, respectively. XRD analysis confirmed a wurtzite crystalline phase in all annealed films, with an additional secondary silver phase. The films exhibited both high optical transparency and electrical conductivity, with transmittance in the visible range (600 nm) varying between 60% and 80%. Notably, the multilayered configuration demonstrated an optimal figure of merit of 2.68×10^{-3} nm·Ω^{-1}, underscoring its potential for optoelectronic applications.

Paper ID 26

Recent Advances in the Application of TinyML and Edge Devices in Solar Photovoltaic Systems: Bridging the gap between laboratory research and industry

Authors: Adel Mellit (Jijel university)*

Abstract

With advancements in Artificial Intelligence (AI) techniques and embedded systems, various platforms have been developed to design and deploy Tiny Machine Learning (TinyML) on edge devices for real-time applications. TinyML enables ML models to run efficiently on resource-constrained devices, making it particularly useful in solar photovoltaic (PV) systems. This paper briefly overviews potential TinyML applications in solar PV systems, including solar energy forecasting, fault detection and diagnosis, predictive maintenance, and more. Recent applications are discussed regarding the edge devices used, platforms, accuracy and real-time deployment. Most research in this topic is still conducted at the laboratory scale; therefore, bridging the gap

between laboratory research and industry is crucial for transitioning from theory to real-world applications. The paper also discusses the challenges and outlines future directions for implementing embedded ML on edge devices in real-world PV system applications.

Paper ID 27

Performance and Emission Analysis of LPG-Hydrogen Dual Fuel Engines

Authors: Hassina Ghodbane (High national school of renewable energy environment and sustainable development)*; Fouad khaldi (High national school of renewable energy environment and sustainable development); Derradji Bahloul (High national school of renewable energy environment and sustainable development)

Abstract

This study presents a computational fluid dynamics (CFD) investigation into the effects of hydrogen enrichment in a liquefied petroleum gas (LPG)-fueled spark-ignition engine. A four-cylinder CLIO2 engine was simulated using AVL FIRE software with hydrogen fractions of 12%, 22%, and 32% by volume added to LPG. The results show that hydrogen addition significantly enhances engine thermal efficiency and power output while also influencing combustion dynamics and emissions. As the hydrogen content increased from 12% to 32%, thermal efficiency improved by 25% (from 54% to 67.5%), with the most significant gains observed between 12% and 22% H_2. Power output rose linearly from 42 kW to 48 kW, representing a 14.3% increase. Peak in-cylinder pressure and temperature rose modestly by 3% and 5.3%, respectively, indicating enhanced combustion without inducing critical mechanical stress. However, this performance improvement was accompanied by a substantial increase in NO_x emissions, which rose by 66.7% (from 4200 ppm to 7000 ppm), primarily due to elevated combustion temperatures associated with hydrogen's high flame speed and reactivity. These findings suggest that while hydrogen enrichment improves engine performance, an optimal blending range between 20% and 25% hydrogen by volume is recommended to balance thermal efficiency gains and NO_x emission control.

Paper ID 28

PSO Algorithm for Optimal of Fuzzy Logic Controller for A DC-DC Buck Converter

Authors: ahmed BENNAOUI (Laboratoire des semi-coducteurs et matériaux fonctionnels , University of Amar Telidji, Laghouat,)*; Aissa Ameur (University of Amar Telidji); Ameur Bennaou (University of Constantine 2 Computer sciencesr); Salah BENZIAN (University of aflou)

Abstract

This study demonstrates the effectiveness of the Particle Swarm Optimization (PSO) method in enhancing the performance of Fuzzy Logic Controllers (FLCs) within DC-DC buck converters. A comparative analysis reveals that the PSO-optimized FLC exhibits superior performance when juxtaposed with a conventional FLC. The findings underscore the efficacy of integrating the PSO algorithm with FLCs to achieve optimal parameter tuning, specifically within the application of DC-DC buck converters. The quantitative results, assessed using Integral Squared Error (ISE) and Integral Absolute Error (IAE) metrics, underscore the efficacy of integrating the PSO algorithm with FLCs. This integration facilitates a data-driven approach to achieve optimal parameter tuning, specifically within the demanding application of DC-DC buck converters where precise voltage regulation is paramount.

Paper ID 30

Hybrid WCA-HS Based Control for Autonomous Quadrotor Navigation in Precision Agriculture

Authors: NESRINE TENNICHE (Université de Bejaia)*; Boubekeur MENDIL (Universite de Bejaia); FARID GHILAS (Universite de Bejaia); LAMINE BRIKH (Universite de Bejaia)

Abstract

Autonomous Unmanned Aerial Vehicles (UAVs) are increasingly used in precision agriculture to support
sustainable land and water management through efficient monitoring. This paper presents a control method based on the recently developed hybrid metaheuristic algorithm, Water Cycle Algorithm–Harmony Search (WCA-HS), to optimize control laws for improved trajectory tracking of a quadrotor UAV. The approach is evaluated using the Integral of Timeweighted Absolute Error (ITAE) cost function and benchmarked against five established optimization algorithms: WCA, HS, Differential Evolution (DE), Particle Swarm Optimization (PSO), and Artificial Bee Colony (ABC). Results demonstrate superior performance in tracking accuracy, convergence speed, and control stability. This work supports advanced UAV-based solutions for water-efficient, renewable

powered agriculture, aligning with the goals of integrated food, water, and energy systems.

Paper ID 31

Fault Diagnosis of Induction Motors Using Convolutional Neural Networks

Authors: Benyamine ARROUL (university of bejaia)*

Abstract

Abstract— Induction motors are among the most widely used machines in industrial and renewable energy systems, particularly in solar powered agricultural applications where reliability is crucial. Their failure can lead to significant financial losses and operational disruptions. This study proposes a Convolutional Neural Network (CNN) based method for fault diagnosis using acoustic signals converted into two-dimensional image representations. The model achieves a classification accuracy of 93.94%, significantly outperforming traditional techniques. This approach enables accurate, real time fault detection, minimizes unplanned downtime, and supports predictive maintenance strategies. By enhancing motor reliability, especially in sustainable energy infrastructures, this work contributes to the development of smarter and more energy efficient systems.
Keywords—Convolutional Neural Networks (CNNs), Induction Motors, Fault Diagnosis, Acoustic Signals, Predictive Maintenance.

Paper ID 33

SOLAR INVERTER PERFORMANCE PREDICTION USING DOUBLE EXPONENTIAL CURVE FITTING

Authors: Lyazid KACI (UMMTO)*; Amar HADJ ARAB (CDER); Rachid ZIRMI (UMMTO)

Abstract

Keywords: PV systems; Grid connected PV inverters; Inverter efficiency modeling; Double exponential curve fitting.
Abstract: In this paper, a performance model is developed for grid-connected photovoltaic inverters based on field data from the outdoor PV system of the Renewable Energy Development

Center (CDER) at the height of Algiers. The model is based on double exponential curve fitting method. The model expresses the inverter performance as a function of the inverter AC output power based. The accuracy of the developed double exponential model is compared to the SANDIA National laboratories for the SMA single phase inverter. The performance model of the grid-connected photovoltaic inverters can be used for PV system performance modeling and for continuous monitoring of inverter performance during system operation

Paper ID 36

Advanced Polynomial and Gaussian Regression Frameworks for Predictive Modeling of Tangential Discharge Phenomena in High-Voltage Insulation Systems

Authors: Nabila SAIM (université Mouloud MAMMERI de Tizi Ouou)*; Ferroudja Bitam-Megherbi (University of Mouloud Mammeri, Tizi Ouzou)

Abstract

This paper proposes and rigorously evaluates two advanced regression-based frameworks—Polynomial Regression (PR) and Gaussian Regression (GR)—for predictive modeling of tangential discharge phenomena at triple junctions (TJs) within high-voltage (HV) insulation systems. A custom-designed experimental setup was developed to characterize the maximum discharge current (I_{max}) as a function of voltage application time (t) and surface condition (clean t′, abraded t″). Experimental data were acquired from silicone, porcelain, and heat-tempered glass specimens subjected to 12 kV at a 2.9 cm gap. Results show that while polynomial models offer reasonable predictive accuracy ($R^2\_adj \approx 0.977$), Gaussian regression provides superior performance with R^2_adj values up to 0.9998 and RMSE below 0.5 μA. These results underscore the Gaussian model's capability to capture nonlinear discharge dynamics with high fidelity, particularly under surface deterioration. The proposed framework offers a low-cost, data-driven alternative to conventional empirical diagnostics, enabling early detection of insulation aging and defects. The validated models support predictive maintenance and pave the way for intelligent monitoring in HV systems. Future work aims to extend the methodology to include real-time sensor data for enhanced adaptive diagnostics.

Paper ID 38

Determination of the Minimum Capacitance for self-excitation of a SEIG, taking into account the Speed Ramp Up

Authors: Madjid SI BRAHIM (Mouloud MAMMERI University)*; Rabah ROUAS (Laboratoire LATAGE, Université Mouloud MAMMERI, Tizi-Ouzou); Rahma KACHENOURA (Laboratoire LATAGE, Université Mouloud MAMMERI, Tizi-Ouzou); Salah HADDAD (Laboratoire LATAGE, Université Mouloud MAMMERI, Tizi-Ouzou)

Abstract

The determination of the minimum capacitance required for the self-excitation of a self-excited induction generator (SEIG), has already been the subject of several previous studies. It has been shown the minimum capacitance depends on the rotation speed and the remanent magnetism of the SEIG. The study carried out in this paper shows that in addition to the rotation speed and the remanent magnetism, there is the third parameter, which has an influence on the self-excitation process of the SEIG. It is the acceleration or in other words the rotation speed ramp-up. In this paper, several experimental self-excitation tests for different values of the rotation speed ramp-up are carried out leading to new characteristics of the minimum self-excitation capacitance as a function of the rotation speed of the SEIG. A dynamic model of the SEIG is developed under MATLAB-Simulink software in order to compare the experimental characteristics with those obtained numerical simulation.

Paper ID 40

Advancing Infiltration Modeling with Deep Learning: A Superior Alternative to Empirical Approaches in the Mitidja Plain

Authors: AMINA MAZIGHI (ENSH)*; MOHAMED MEDDI (ENSH); Hind MEDDI (ENSH)

Abstract

Irrigation planning and flood risk assessment are critical challenges, particularly in semi-arid regions. This study evaluates the performance of deep learning models—Long Short-Term Memory (LSTM) and Multi-Layer Perceptron (MLP)—in predicting infiltration rates across 70 experimental sites in the Mitidja Plain, Algeria, and compares them with traditional empirical models, namely Philips and SCS. Given the limitations of empirical models in capturing the complexity of infiltration dynamics, machine learning offers a powerful alternative for improving prediction accuracy. The LSTM model, designed with two layers (100 and 50 units) and dropout

regularization, effectively captures temporal dependencies, while the MLP model, tested with different dimensional configurations, serves as a strong benchmark for static regression tasks. Results indicate that MLP outperforms all other models, achieving a coefficient of determination (R^2) of 0.95, compared to 0.81 for LSTM. In contrast, empirical models demonstrated lower accuracy, with SCS performing better than Philip. These results confirm that deep learning, particularly MLP, provides a more accurate and robust solution for infiltration modeling compared to classical empirical approaches.
These findings highlight the transformative potential of artificial intelligence in hydrological studies, offering enhanced precision for soil and water conservation strategies in semi-arid environments. This study contributes to optimizing infiltration estimation and supports the integration of advanced computational methods into hydrology for improved water resource management in the Mitidja Plain, Algeria. Future research should explore hybrid approaches that combine empirical knowledge with deep learning techniques for further refinement.

Paper ID 43

Real-Time Sensorless Control for PMSG Wind Generators Using Step-by-Step Sliding Mode Observer on STM32

Authors: Sofiane BENABIT (University Mouloud Mammeri of Tizi-Ouzou Control Engineering Department Tizi-Ouzou, Algeria); Hocine KHATI (Design and Drive of Production systems Laboratory University Mouloud Mammeri of Tizi-Ouzou Tizi-Ouzou, Algeria); Arezki FEKIK (Ecole centrale de nantes)*; Malek GHANES (Ecole centrale de nantes)

Abstract

This paper presents a Processor-in-the-Loop (PIL) implementation of a Step-by-Step Sliding Mode Observer (SBS-SMO) for sensorless estimation of rotor position and electrical speed in Permanent Magnet Synchronous Machine (PMSMs) used as generators in wind energy systems. The objective is to provide a reliable and cost-effective solution for real-time control of wind generators within the renewable energy sector. The observer is implemented on a low-cost STM32 microcontroller, using both floating-point and fixed-point arithmetic. A comparative performance analysis, including execution time and processor load, highlights the trade-offs between estimation accuracy and computational efficiency. Experimental results demonstrate the practical feasibility of robust, real-time, sensorless control using embedded systems tailored for wind energy applications, with reduced cost and minimal hardware complexity.

Paper ID 44

Robust Generalized Predictive Speed with Direct Torque Control for Multiphase Wind Generators under Parametric Uncertainty

Authors: ouari kamel (University of Bejaia)*; kasri Amel (University of Bejaia); Belkhier youcef (University of Brest); Boudries Zoubir (University of Bejaia)

Abstract

The increasing complexity and variability of wind energy conversion systems (WECS) demand innovative and highly robust control solutions to ensure optimal performance under uncertain and fluctuating operating conditions. This paper introduces a new robust generalized predictive speed controller, integrated with Direct Torque Control (RGP-DTC) designed for Dual Star Induction Generators (DSIGs) in advanced wind energy systems. The proposed control architecture is built upon a nonlinear model predictive control framework enhanced with a novel cost function, which ensures excellent steady-state accuracy and strong rejection of disturbances. The new robust controller significantly improves resilience to parameter uncertainties,achieving this without mechanical sensors or explicit disturbance estimation. Comprehensive simulation results, performed under variable wind speeds and substantial parametric variations, clearly demonstrate the proposed method's superior dynamic response, robustness, and tracking performance, making it an up-and-coming control solution for next-generation wind energy applications.

Paper ID 49

An Embedded AI Model for Defect Detection in Photovoltaic Modules Using a Jetson Nano-Powered Unmanned Aerial Vehicle

Authors: Nouamane Kellil (Unité de Développement des Equipements Solaires UDES/Centre de Développement des Energies Renouvelables CDER BP 42415, Tipaza)*; Adel Mellit (Univ of Jijel); Toufik Benkherouf (Département d'Aéronautique, Centre de Recherche et Développement); Maamar Bettayeb (University of Sharjah, Sharjah)

Abstract

In this work, we propose an embedded computer vision system based on a You Only Look Once (YOLO) model, suitable for real-time defects detection in photovoltaic (PV) plants. The dataset is a set of images taken using an RGB camera, capturing various types of PV module defects. A

YOLOv9-based detection pipeline was developed and optimized for this dataset to serve as a benchmark. The core YOLOv9 model was then fine-tuned and integrated into a lightweight architecture suitable for deployment on resource-constrained hardware. The final implementation was carried out on an NVIDIA Jetson Nano platform, enabling real-time inference capabilities in embedded environments. Experimental results validate the effectiveness of the designed prototype, demonstrating high detection accuracy and efficient performance, confirming its suitability for practical field deployment.

Paper ID 52

Two Step Ahead Finite Set Predictive Torque Control Using Improved Sliding Mode Control for Three Phase Induction Motor

Authors: Sofiane Brahami (Université de Bejaia, Faculté de Technologie, Laboratoire de Maîtrise des Energies Renouvelables (LMER), 06000 Bejaia, Algeria)*; Kaci Ghedamsi (Université de Bejaia, Faculté de Technologie, Laboratoire de Maîtrise des Energies Renouvelables (LMER), 06000 Bejaia, Algeria); Yanis Hamoudi (Université de Bejaia, Faculté de Technologie, Laboratoire de Maîtrise des Energies Renouvelables (LMER), 06000 Bejaia, Algeria); Abdelyazid Achour (Université de Bejaia, Faculté de Technologie, Laboratoire de Technologie Industrielle et de l'Information (LTII), 06000 Bejaia, Algeria)

Abstract

This paper presents an enhanced control strategy for three-phase induction motor (IM) drives based on two step ahead Finite-Set Predictive Torque Control (FS-PTC) integrated with improved Sliding Mode Control (SMC) scheme. Conventional FS-PTC typically employs a Proportional-Integral (PI) controller for speed regulation. However, the performance of PI controller is highly dependent on accurate motor parameters and is significantly degraded under varying load conditions, leading to poor speed tracking and limited robustness. To address these challenges, a novel FS-PTC based SMC framework is proposed, leveraging the disturbance rejection and robustness characteristics of SMC while preserving the fast dynamic response and constraint-handling capabilities of FS-PTC. The effectiveness of the proposed control scheme is verified through comprehensive simulation studies in the MATLAB/Simulink environment. Comparative analysis with the conventional FS-PTC+PI approach demonstrates that the FS-PTC+SMC system achieves superior speed tracking, reduced torque ripple, and enhanced robustness against load disturbances and rotor resistance variation.

Paper ID 53

Security of Grid-Connected Photovoltaic Plants A Mini-Review and Future Directions

Authors: Nassiha Boutana (University of Science and Technology Houari Boumediene)*; Rokia chekirou (University of Jijel); Adel Mellit (University of Jijel); Maamar Bettayeb (University of Sharjah)

Abstract

Photovoltaic systems are becoming increasingly vulnerable to cyber-attacks and threats as they are connected into modern energy grids, which can affect both their physical and digital components. Therefore, Cyber security is essential for maintaining the grid stability, energy reliability and safety. This paper provides a mini review of cyber-physical security in grid connected photovoltaic (GCPV) systems. Moreover, a new configuration based on the concept of secure artificial intelligence of things (SAIoT) is proposed and examined. Detection methods and mitigation strategies against possible threats and cyber-attacks are discussed and highlighted, with a particular focus on AI machine learning (ML) and deep learning (DL) approaches. This work serves as a prelude to further research and practical applications in this topic.

Paper ID 55

Comparative Study of the Different Structures of Multi-Level Inverters for the Connection of PV Systems to the Power Grid

Authors: BENABDA Amina (Badji Mokhtar university annaba)*

Abstract

The objective of this article is to demonstrate that in a system connected to the grid and supplying a non-linear load, multilevel inverters improve power quality more effectively than conventional inverters, and to evaluate and compare the performance of different multilevel inverter structures through a series of numerical simulations. In addition, we seek to prove that increasing the number of levels leads to a reduction in the total harmonic distortion (THD) rate. As part of this study, we compared two-level inverters with filters and three- and five-level NPC inverters without filters. The methodology adopted is based on the use of the MATLAB/Simulink environment, which offers flexibility and precision suitable for modelling power electronic systems. Based on simulated models, the results obtained allow a comparative analysis between the different configurations tested.

Paper ID 57

Comparative Analysis of MPPT Algorithms for Photovoltaic Systems Under Partial Shading: A MATLAB/Simscape-Based Study

Authors: Ahmed Chebri (HNS-RE2SD)*; Fatima Zohra BOUKAHIL (HNS-RE2SD); Assala MOUFFOUK (HNS-RE2SD); Boubekeur AZOUI (HNS-RE2SD)

Abstract

The performance of photovoltaic (PV) systems is highly sensitive to partial shading, which can introduce multiple power peaks and significantly reduce energy yield. This paper investigates and compares three Maximum Power Point Tracking (MPPT) algorithms Perturb and Observe (P&O), Fuzzy Logic Control (FLC), and an improved Sliding Mode Control (SMC) under partial shading conditions. The system and algorithmic approaches are implemented and simulated using MATLAB/Simscape. Simulation results show that the conventional P&O algorithm fails to track the Global Maximum Power Point (GMPP), converging instead to a local maximum. In contrast, both FLC and improved SMC successfully reach the GMPP. Among them, the FLC algorithm achieves the fastest response time (0.006 s), the lowest power loss, and the highest partial shading efficiency (99.7%), outperforming the others in accuracy and stability. These findings highlight the effectiveness of intelligent and nonlinear control strategies in optimizing PV system performance under non-uniform irradiance.

Paper ID 58

Energy-Efficient and Sustainable Approaches to AS/RS Design and Control: A Comprehensive Review

Authors: BAHMID Omar (Univ Tlemcen)*; Sihem Kouloughil (Univ Tlemcen); Bendiouis Amaria (Univ Tlemcen)

Abstract

In the pursuit of sustainability, controlling energy consumption to prevent wasteful usage has become a critical goal across industries. Within this context, improving energy efficiency represents a key focus in Automated Storage and Retrieval Systems (AS/RS). This comprehensive review examines recent advancements in AS/RS design, control, and operation, with particular emphasis on energy optimization and sustainable practices. The analysis encompasses system configurations, scheduling methodologies, control algorithms, and simulation-based evaluations to provide a

holistic understanding of current approaches. This study synthesizes existing research to identify emerging trends, reveal methodological preferences, and establish directions for future investigations in energy efficient AS/RS development.

Paper ID 59

A Novel Linguistic Hedge-Based Fuzzy Logic Controller for Enhanced MPPT in PV Systems

Authors: Chellali Benachaiba (Tahri Mohamed University)*

Abstract

Maximum Power Point Tracking (MPPT) is critical for optimizing photovoltaic (PV) system efficiency under varying environmental conditions. While conventional fuzzy logic controllers (FLCs) have been widely adopted for MPPT, their performance can degrade under rapid irradiance changes and partial shading due to membership function shape. This paper introduces a novel linguistic hedge-based fuzzy MPPT controller that refines membership function shape using hedges (e.g., "very," "slightly") to adapt system response. By modulating the membership function shape, the proposed method enhances tracking precision and reduces oscillations compared to traditional FLCs. The controller is validated through MATLAB/Simulink simulations. Results demonstrate that the proposed controller outperforms the standard fuzzy PV MPPT by improving the tracking efficiency by 31.65% at 0.04 s and reducing the oscillations. The study bridges a gap in fuzzy MPPT literature by integrating linguistic hedges, offering a scalable solution for PV systems requiring high adaptability.

Paper ID 61

Tuning of a Neutrosophic Fuzzy Controller for DC Motor Using the Novel Exemplar-Guided Metaheuristic

Authors: Chellali Benachaiba (Tahri Mohamed University)*

Abstract

Precise speed control of DC motors is critical for industrial applications. This paper presents a novel Neutrosophic-Fuzzy PID (NFPID) controller, combining Neutrosophic Logic (NL) and Fuzzy Logic (FL), and compares its performance with a classical PID controller. Initial results

demonstrate the superior performance of the NFPID over conventional PID in terms of responsiveness and stability. To further enhance the controller's efficiency, we introduce the Exemplar-Guided Metaheuristic (EGM), a novel optimization algorithm, to optimize the NFPID's scaling factors. The optimized controller exhibits exceptional performance, significantly reducing transient oscillations and improving dynamic response compared to both the baseline NFPID, a PSO-optimized NFPID, and the classical PID. The results validate that the proposed metaheuristic-optimized NFPID outperforms traditional and other metaheuristic-tuned methods, offering a robust solution for DC motor control.

Paper ID 64

Two-Level Hierarchical Control of a PV-Battery Hybrid Energy System Using Differential Flatness-Based Strategy and MShOA-Tuned FOPID Controller

Authors: Hadjer CHABANA (national higher school of technology and engineering annaba)*; Ilyes TEGANI (University Center of Barika, Barika, Algeria); Hamza AFGHOUL (University of Ferhat Abbas Setif-1); Soumia MERAH (National Higher School of Technology and Engineering, Annaba, Algeria)

Abstract

This work provides a two-level hierarchical control for a hybrid energy system (HES) composed of a photovoltaic (PV) source and a battery bank connected to a DC bus. The primary-level controller is based on a differential flatness strategy, which offers optimal energy balancing between the PV source, the battery, and the load by generating accurate reference current trajectories. The secondary-level controller is a Fractional Order PID (FOPID) controller whose parameters are tuned using the Mantis Shrimp Optimization Algorithm (MShOA), which is a recent bio-inspired metaheuristic optimization. This inner loop is responsible for the real-time regulation of the DC bus voltage by accurately tracking the current reference signals. The MATLAB/Simulink simulation results under dynamic load conditions validate the effectiveness of the proposed approach and demonstrate improved performance compared to conventional methods

Paper ID 67

Sustainable Power Generation via Olive Solid Waste Gasification in the Tizi Ouzou Region.

Authors: ABDENOUR ELIAS (Université of BLIDA 1)*; Abderrezak Kennas (university of Boumerdes)

Abstract

Each year, mills in the Kabylia region generate thousands of tons of olive-wastes , which is typically discarded or burnt in fields. This study addresses the valorisation of olive solid waste through gasification. A theoretical study and simulation were conducted on a small-scale plant designed for heat and power generation. The plant consists of a downdraft gasifier, an externally fired gas turbine, and an organic Rankine cycle. The syngas produced in the gasification process showed the following molar composition: H_2 16.86%, CO 20.66 %, CH_4 1.62%, CO_2 9.4%, and N_2 50.7%. The syngas had an LHV of 4.71 MJ/kg and a gasification efficiency of 72.15%. When supplied with 112 kg/h of olive pomace, the EFGT generated an electrical output of 75.8 kWe. The flue gases exiting the turbine powered the organic Rankine cycle, facilitating the generation of both electrical and thermal energy. This study evaluates the performance of six working fluids: cyclohexane, isopentane, R113, benzene, R245fa, and methanol. Among these fluids, isopentane demonstrated the highest electrical power output, producing 35.4 kWe and achieving a combined total output of 111.2 kWe. This resulted in an improvement in electrical efficiency from 18.3% to 24.07%. Based on the thermodynamic performances, a thermo-economic evaluation was conducted, incorporating the sale of both electricity and thermal energy in the form of hot water. To evaluate the economic viability of the system, four key indicators were calculated: net present value, profitability index, internal rate of return, and payback period. The cost-free availability of biomass significantly contributed to favourable economic outcomes.

Paper ID 68

A Heuristic Optimization Approach for Wind Turbine Dimensions to Enhance Energy Capture and Reduce Costs

Authors: Mourad Naidji (Department of Electrical Engineering, Badji Mokthar University)*; Mohamed Ilyas Rahal (Badji Mokhtar); Alla Eddine Toubal Maamar (University of M'hamed Bougara of Boumerdes); Aicha Aissa-Bokhtache (Hassiba Benbouali University of Chlef); Maamar Latroch (Hassiba Benbouali); Radu-Florin Porumb (University POLITEHNICA of Bucharest)

Abstract

Emerging as a vital component in the worldwide shift towards environmentally friendly power generation is wind energy. Maximizing energy output and reducing cost depend on well-designed

wind farms, particularly considering the growing demand for renewable energy. This work expands on several ideal wind turbine configurations suggested in previous work and chooses them as basis for more thorough investigation and enhancement. While most previous studies have concentrated mostly on lowering the cost per kilowatt of generated power, this work takes a more all-encompassing view aiming to improve general wind farm efficiency through strategic optimization of turbine tower heights and rotor diameters, so simultaneously lowering total costs. This kind of approach might produce more flexible and efficient wind farms. A Particle Swarm Optimization (PSO) method is used to find the best arrangement of rotor diameters and tower heights over the wind farm in order to reach these targets.

Paper ID 70

Surpassing 16% Efficiency in Cd-Free CZTS Solar Cells via Si Back-Contact Engineering and IR Harvesting

Authors: Lynda METREF (Ecole Superieure des Techniques de l'Aeronautique)*; ESSAID MANSOURI (Ecole Superieure des Techniques de l'Aeronautique); Mahfoud ABDERREZEK (UDES/CDER); Samira SALI (CRTSE)

Abstract

We introduce a fully Cd-free CZTS solar cell architecture modeled in SCAPS-1D, featuring a ZnO:Al front contact, ZnS buffer, primary CZTS absorber, an ultrathin (~200 nm) p-type Si interlayer on a Mo back contact, and a supporting p-Si substrate that also serves as a secondary absorber. Through systematic optimization of layer thicknesses, doping levels, mobilities, and work functions, the p-Si interlayer effectively reduces back-contact recombination and extends spectral absorption into the near-infrared. Simulations under AM1.5G illumination at 300 K indicate a power-conversion efficiency exceeding 16% with Voc≈ 0.98 V, Jsc≈ 24.6 mA/cm², and FF ≈ 68.7%. These results demonstrate that the integrated p-Si layer not only enhances device performance and mechanical stability but also validates the potential of SCAPS-1D as a predictive tool for designing environmentally benign, high-performance kesterite-based photovoltaics.

Paper ID 71

Analysis of Long-Term Performance Degradation in Photovoltaic Modules

Authors: Amar HADJ ARAB (CDER)*

Abstract

This study investigates the long-term performance degradation of 15 crystalline silicon photovoltaic (PV) modules from the first grid-connected PV system installed at the Centre de Développement des Energies Renouvelables (CDER) in Algiers, Algeria, located along the Mediterranean coast. In continuous operation since 2004, the system provides a valuable case for assessing real-world aging effects. Despite sharing identical nominal specifications, manufacturing origin, and installation conditions, the modules exhibited varying degradation rates. After 20 years of outdoor exposure (2004–2024), seven of the fifteen modules showed power losses exceeding the standard warranty limit of 20% nominal power degradation.

Paper ID 72

Smart Energy Control in PV-Battery Systems Using Three-Level Boost Converters with DC-Link Voltage Regulation via Genetic Algorithm

Authors: BAHRI Ahmed (Laboratry of MESTEL, University of Ghardaia)*; Mezhoud Nabil (Electrical Engineering Department LES Laboratory,); Ayachi Bilel (Electrical Engineering Department LES Laboratory, University of 20 August 1955-Skikda); Abdelkrim Thameur (Unité de Recherche Appliquée en Energies Renouvelables, URAER); Boukhenoufa Farouk (Electrical Engineering Department LES Laboratory,University of 20 August 1955-Skikda); Bellaouar Abderrahmane (*)

Abstract

This paper presents a novel photovoltaic (PV)–battery hybrid energy system featuring a three-level boost converter (3LBC) to achieve high voltage gain and reduced switching stress. The system is designed to extract maximum power from the PV array, ensure a stable DC-link voltage, and reduce Total Harmonic Distortion (THD) on the load side. A PID controller regulates the battery's charge/discharge process, with its parameters optimally tuned using a genetic algorithm (GA) to enhance dynamic response and overall system stability. The proposed system is modeled and simulated in MATLAB/Simulink. Simulation results validate the effectiveness of the approach in improving power quality, stabilizing the DC-link, and optimizing energy flow, making it well-suited for intelligent renewable energy integration.

Paper ID 73

Comparative Optimal Dispatch Control Strategies For a Hybrid Renewable Energy System

Authors: Mourad Zebboudj (Université de Béjaia)*; Djamila Rekioua (Université de Bejaia); Toufik Rekioua (Université de Bejaia)

Abstract

This research presents a study on a hybrid renewable energy system that integrates battery storage with photovoltaic panels, wind turbines, and a diesel generator. The study was conducted in Bejaia, Algeria, which possesses substantial potential for wind and solar energy resources. The integration of the diesel generator is essential as an auxiliary source to compensate for the intermittency of renewable resources, but it requires precise sizing according to daily peak load demands. The stand-alone system architecture is simulated under two different optimization algorithms using HOMER Pro (open-source version): combined dispatch (CD) and predictive dispatch (PS), to determine the optimal system cost. The impact of various component prices on the net present cost (NPC) and the cost of energy (COE), along with the emissions of polluting gases following diesel generator integration, were evaluated using sensitivity analysis. The results demonstrate that the predictive dispatch algorithm clearly outperforms the combined dispatch approach in optimizing investment costs, while the combined dispatch strategy achieves greater reductions in emissions and fuel consumption by the diesel generator.

Paper ID 75

Advancements in Solar Energy Systems: Innovations in Photovoltaic (PV) and Floating PV Technologies for Decentralized Energy Production

Authors: Mourad Naidji (Department of Electrical Engineering, Badji Mokthar University)*

Abstract

Solar energy has seen remarkable technological advancements with photovoltaic (PV) and floating PV (FPV) technologies leading the way in decentralized power solutions. These technologies not only enhance solar efficiency and affordability but also enable intelligent integration into smart grids, hence enhancing the sustainability and scalability of clean power. This essay delves into next-generation technologies driving the revolution of PV and floating PV systems, their economic viability, environmental-friendliness, and capacity to alter the global energy landscape. The theme of policy incentives and education as drivers of deployment will be shown, and their importance in the future of sustainable energy generation will be emphasized.

Paper ID 77

Sensorless Voltage-Oriented Control of Modular Multilevel Converters for Wind Power Systems

Authors: Mustapha Asnoun (L2CSP Laboratory, Mouloud Mammeri University of Tizi-Ouzou)*; Adel Rahoui (Ecole Nationale Supérieure des Travaux Publics); Koussaila Mesbah (L2CSP Laboratory, Mouloud Mammeri University of Tizi-Ouzou); Boussad Boukais (L2CSP Laboratory, Mouloud Mammeri University of Tizi-Ouzou); Noumidia Amoura (L2CSP Laboratory, Mouloud Mammeri University of Tizi-Ouzou); Seddik Bacha (Univ. Grenoble Alpes, CNRS, Grenoble INP, G2ELAB)

Abstract

Currently, Modular Multilevel Converters (MMCs) have emerged as a state-of-the-art solution for electrical energy conversion, particularly in High Voltage Direct Current systems. In order to ensure efficient and stable operation, it is essential to implement appropriate control techniques. Conventional control strategies, such as Voltage Oriented Control (VOC) or predictive control, generally require direct measurement of grid voltages. However, in the presence of disturbances, such measurements can compromise the robustness and stability of the system. In order to address this issue, the present paper investigates a sensorless control approach based on Virtual Flux (VF) estimation, which eliminates the need for direct voltage measurement. The proposed control strategy is based on VOC, combined with a submodule balancing algorithm to ensure reliable MMC operation. This study evaluates two VF estimation techniques: one using a Low-Pass Filter (LPF) and the other employing a Second-Order Generalized Integrator (SOGI). The simulation results carried out in MATLAB/Simulink demonstrate that the SOGI-based approach ensures optimal dynamic performance, enhanced accuracy, and zero steady-state error. Furthermore, studies conducted under highly distorted voltage conditions highlight the superior robustness of this method compared to the LPF approach. These findings highlight the relevance of the proposed sensorless control strategy for MMC, particularly in wind energy systems where grid disturbances are frequent and reliable operation is critical.

Paper ID 78

A prototype design of Smart DC Power Device for Solar System application

Authors: Saad khadar (University of Djelfa)*; Larbi Brahimi (University of Djelfa); Mohamed Elbar (University of Djelfa); Meriem Ghezal (University of Djelfa); Aya Mebarki (University of Djelfa); Sif Eddine Souadia (University of Djelfa)

Abstract

Energy monitoring and management is an essential element of modern electrical systems, especially in applications that require precision and efficiency to ensure optimal energy consumption. This project aims to develop a prototype design of smart DC power device that provides accurate measurements of voltage, current, and energy consumption, with the ability to track data in real time. Designed to be reliable and accurate, with seamless integration with Internet of Things (IoT) platforms such as Blynk application, the measurement device can be used in a wide range of applications, including solar system application, making it an innovative and efficient solution for monitoring power/energy consumption with high accuracy.

Paper ID 80

Data-Driven based Sparse Identification of Nonlinear Dynamics for Stability Analysis of Mixed Grid-Following and Grid-Forming Inverters

Authors: Houssam Deboucha (University of Bejaia)*; Bessam Deboucha (University of Malaya); Elyazid Amirouchz (University of Bejaia); Said Aissou (University of Bejaia); Ali Berboucha (University of Bejaia); Kaci Ghedamsi (University of Bejaia); Saad Mekhilef (Swinburne University of Technology)

Abstract

The growing penetration of inverter-based resources (IBRs) in modern power systems has introduced significant dynamic complexity and challenges in microgrids, frequently giving rise to instability and pronounced transient phenomena, particularly under islanded operating conditions. In this paper, a pure data-driven modelling framework based on Sparse Identification of Nonlinear Dynamical Systems (SINDy) has been proposed, enhanced through delay embedding via Hankel matrices, to analyse the transient dynamics of hybrid Grid Following (GFL) and Grid Forming (GFM) inverters. Proper Orthogonal Decomposition (POD) is applied to extract the dominant spatial-temporal modes. The effectiveness of the proposed approach is demonstrated and validated through numerical simulations against Hankel Dynamic Mode Decomposition (DMD), involving both time-domain and eigenvalue analysis on a microgrid with diverse grid-forming (GFM) control architectures, including Droop control, Dispatchable Virtual oscillator, and Grid Following (GFL) inverter with PLL. The model-free design SINDy-based framework

successfully captures system dynamics and enables rigorous stability assessment of both GFM and GFL inverters based on the available measurements.

Paper ID 83

Hippopotamus Optimization Algorithm-Based Robust Tilt-FOID Control Design for Linear Time-Invariant Systems in Renewable Energy Applications

Authors: Elouahab Bouguenna (CDER)*

Abstract

This study proposes an advanced hybrid control framework that integrates the novel hippopotamus optimization algorithm (HOA) with a tilt fractional-order integral-derivative (TFOID) controller for linear time-invariant (LTI) systems, with a particular focus on automatic voltage regulator (AVR) applications. By combining tilt control action with fractional-order dynamics, the TFOID controller enhances closed-loop performance through improved frequency response shaping and superior handling of system nonlinearities. The HOA is employed to systematically fine-tune the TFOID parameters, ensuring optimal setpoint tracking and smooth control effort. Comparative time-domain and frequency-domain simulations demonstrate that the proposed nonlinear TFOID feedback controller significantly outperforms conventional Tilt-PID and FOPID structures in terms of transient response, robustness, and overall closed-loop stability. These results validate the effectiveness and correctness of the HOA-TFOID design in enhancing dynamic performance and maintaining voltage regulation under varying operating conditions.

Paper ID 84

Modeling High-Performance Cs0.05(FA0.77MA0.23)0.95Pb(I0.77Br0.23)3 Perovskite Solar Cells via SCAPS-1D Simulation

Authors: abderrahim YOUSFI (University Mohamed El Bachir El Ibrahimi of Bordj Bou Arréridj)*

Abstract

This study presents a novel heterostructure perovskite solar cell incorporating a Cs0.05(FA0.77MA0.23)0.95Pb(I0.77Br0.23)3 absorber layer, with

PCBM serving as the electron transport layer (ETL) and CuSbS2 as the hole transport layer (HTL), modeled using SCAPS-1D simulations. The simulated device architecture, ITO/PCBM/Cs0.05(FA0.77MA0.23)0.95Pb(I0.77Br0.23)3/CuSbS2/Ag, demonstrated outstanding photoconversion performance. To optimize cell efficiency, key parameters were systematically varied, including the type and thickness of ETL and HTL layers and absorber thickness. The optimized configuration achieved a high open-circuit voltage (VOC) of 1.12 V, a short-circuit current density (JSC) of 29.84 mA/cm2, a fill factor (FF) of 83.78%, and a power conversion efficiency (PCE) of 28.01%, in strong agreement with existing literature benchmarks.

Index Terms—Cs0.05(FA0.77MA0.23)0.95Pb(I0.77Br0.23)3, efficiency (PCE), solar cell, SCAPS-1D.

Paper ID 85

Bio-inspired Method for Optimal Energy Management and Efficiency Improvement of Microgrids

Authors: MEZHOUD Nabil (Electrical Engineering Department, LES Laboratory, Faculty of Technology, University 20 August 1955-Skikda)*; BAHRI Ahmed (Automatics and Electromechanics Department, MESTE Laboratory, Faculté de Science et Technologie, Université de Ghardaia, Algeria, Ghardaia, Algeria); BOUKHENOUFA Farouk (Electrical Engineering Department, LES Laboratory, Faculty of Technology, University 20 August 1955-Skikda); AYACHI Bilel (Electrical Engineering Department, LES Laboratory, Faculty of Technology, University 20 August 1955-Skikda); BOURAS Lakhdar (Electrical Engineering Department, LES Laboratory, Faculty of Technology, Université 20 Août 1955-Skikda); AHMED HAZILA Ilham (Departmentof Technology, Faculty of Technology, Université 20 Août 1955-Skikda)

Abstract

One of bio-inspired meta-heuristic methods called Artificial Hummingbird Algorithm (AHA) is applied to solve the optimal energy management (OEM) and Efficiency Improvement problems of microgrid (MG) enriched with renewable energy sources (RES). AHA method have been examined and tested on MG system composed of different types of DGs, such as wind turbines (WT), photovoltaic systems (PV), micro turbines (MT), fuel cells (FC), diesel electric generator

(DEG), and loads with energy storage systems (ESS). The results are promising and show the effectiveness and robustness of proposed approach to solve the EMO in different scenarios

Paper ID 87

Experimental study of solar water pump control by Arduino

Authors: amina AZIZI (Badji mokhtar)*

Abstract

This study aims to design and implement an automated solar water pumping system controlled by Arduino. The primary objective is to evaluate the efficiency of integrating Maximum Power Point Tracking (MPPT) within a photovoltaic (PV) system to optimize energy extraction under varying sunlight conditions. This system addresses the demand for reliable water access in remote areas with limited conventional energy sources, providing an effective and sustainable alternative that minimizes manual intervention and optimizes energy use

Paper ID 90

Transformer Fault Diagnosis Using HHO-Enhanced XGBoost and Liquid Dielectric Signal Analysis

Authors: bouguettaya tarek bouguettaya (Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj)*; Abderrahim Reffas Reffas (Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj); Mohammed Adaika Adaika (Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj); hichem talhaoui (Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj); Oualid Aissa (Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj); Sherif S. M. Ghoneim Sherif S. M. Ghoneim (College of Engineering, Taif University)

Abstract

This paper presents a novel approach to transformer fault diagnosis based on Dissolved Gas Analysis (DGA) by integrating Harris Hawks Optimization (HHO) with the eXtreme Gradient Boosting (XGBoost) model. Traditional interpretation methods such as Duval Triangle and IEC 60599 face limitations in handling overlapping gas patterns. The proposed model incorporates domain-based gas ratios and utilizes HHO to optimize XGBoost hyperparameters. Evaluation using real DGA datasets shows that the HHO-optimized model achieves superior performance

(97.62% accuracy) compared to the default configuration, highlighting the strength of metaheuristic optimization in enhancing machine learning for high-voltage diagnostics.

Paper ID 91

Advancing Agricultural Robotics: AI Control Strategies for Delta Robots

Authors: Issam KESSIRA (National Higher School of Advanced Technologies)*

Abstract

Delta robots are the most successful parallel robots; their unique mechanical architecture is known for high-speed and precise movements, and due to these features, they are increasingly employed in the agriculture sectors. Originally designed for high-speed industrial tasks, their mechanical structure makes them ideal candidates for a variety of agricultural operations such as fruit packing, precision planting, and rapid crop inspection. However, deploying Delta robots in dynamic and unstructured agricultural environments presents significant control challenges. To fully benefit from their superior characteristics in such environments, they must be controlled using robust control strategies, which is particularly challenging due to their nonlinear behavior and the uncertainties surrounding their models. This article provides an overview of control methods applied to Delta robots in the literature to evaluate their suitability for agricultural tasks, and it highlights the major technical problems faced in this context. A comparative analysis of these methods is offered, ranging from conventional PID controllers to modern intelligent techniques, including AI-based methods, aiming to enhance performance and adaptability in smart farming applications.

Paper ID 92

Using a UAV Crop Monitoring System for Early Tomato Disease Detection and Decision Support

Authors: Dimosthenis Minas (University of Patras)*; Theodosios Chronopoulos (University of Patras); Michalis Xenos (University of Patras)

Abstract

Accurate and early detection of plant diseases is essential for sustaining crop yields and reducing agricultural losses. This paper proposes a UAV-based system for identifying tomato leaf diseases

using the state-of-the-art YOLOv11 object detection model designed to support precision agriculture through automated monitoring. The model was trained and evaluated on a large, publicly available dataset of annotated tomato leaf images, covering a wide spectrum of relevant disease categories. The workflow involves processing high-resolution leaf images to enable real-time detection, classification of multiple disease symptoms and the generation of a simplified health report tailored for farmers. Experimental results demonstrated that the UAV-based system achieved high precision and recall across diverse tomato diseases, outperforming previous approaches in terms of speed and detection accuracy. Field deployment showed that users perceived well the system's output and its value, confirming both the usability and effectiveness of the approach in real agricultural settings. The integration of advanced deep learning techniques with curated open datasets presents a practical and scalable solution for crop health monitoring, supporting the broader adoption of artificial intelligence in precision agriculture.

Paper ID 93

Open-Circuit Fault Diagnosis of a Three-Level Boost Converter for Photovoltaic Applications

Authors: Abdeldjabar BENRABAH (Ecole Militaire Polytechnique)*; Mouaad Belguedri (Ecole Militaire Polytechnique); Mohamed-Amine Yahiaoui (Ecole Militaire Polytechnique); Fayçal Benyamina (Ecole Militaire Polytechnique); Mohamed Benbouzid (University of Brest)

Abstract

Photovoltaic (PV) technology is increasingly adopted due to its minimal environmental impact and broad application potential. However, the reliability of PV systems, particularly power converters, remains a significant challenge limiting wider deployment. This paper addresses this issue by proposing an open-circuit fault diagnosis method for a three-level boost converter used in PV power systems integrated with battery storage. The proposed approach relies exclusively on existing control variables employed for maximum power point tracking (MPPT) and dc-link capacitor voltage balancing, eliminating the need for additional sensors or complex hardware. Numerical simulations conducted in MATLAB/Simulink demonstrate the effectiveness of the proposed diagnostic scheme in accurately detecting open-circuit faults and maintaining system performance.

Paper ID 97

Equivalent Consumption Minimization Strategy for Energy Management in Unmanned Aerial Vehicle

Authors: haroune aouzellag (university of bejaia)*; Sabrina Nacef (university of bejaia)

Abstract

This paper presents an optimal energy management strategy for an unmanned aerial vehicles that utilizes a fuel cell as the primary energy source, a battery as secondary source and as supercapacitor to stabilize the DC bus voltage and handle sudden power variations. This proposed approach is implemented to optimize the distribution of power between the different sources aiming to minimize hydrogen usage while keeping the state of charge of the battery and the supercapacitor within a specified range. Simulation results validate the effectiveness of management in distributing power demand: the supercapacitor absorbs power peaks, and the battery assists the fuel cell during start-up phases and high power demand.

Paper ID 98

Early-Season Water Use Patterns in Wheat and Barley under Semi-Arid Conditions: A Lysimetric Approach

Authors: Omar BOUZIANE (ENSH); MOHAED MEDDI (ENSH)*; Amina MAZIGHI (ENSH)

Abstract

Efficient early-season water use is crucial for optimizing cereal crop performance in semi-arid environments. This study investigates the early water dynamics of wheat and barley during the first 40 days of growth using lysimeter data collected at the Higher National School of Hydraulics in Blida, Algeria. The dataset includes daily measurements of precipitation, evapotranspiration (ETP), soil moisture, and drainage. The analysis reveals that barley initiates evapotranspiration activity earlier than wheat, which correlates with a more rapid depletion of surface soil moisture. In contrast, wheat maintains slightly higher moisture in the root zone, potentially due to slower canopy development and root activity. Importantly, variations in soil moisture content were found to influence drainage behavior, with temporary saturation events in barley plots resulting in minor but detectable drainage losses. These results suggest that early-season soil water status plays a key role in regulating both crop water uptake and percolation processes. This insight contributes to improving early-stage irrigation strategies and crop selection under water-limited conditions.

Paper ID 101

Autonomous Photovoltaic/Thermal Solar Solution for Resilient Isolated Habitats

Authors: Djamila REKIOUA (University of Bejaia)*; Nabil Mezzai (Université de Bejaia); Toufik Rekioua (Universitéé de Bejaia); Zahra Mokrani (Université de Bejaia); Khoudir Kakouche (University of Bejaia); Adel Oubelaid (Université de Bejaia); Chokri Ben Salah (Applied Sciences and Technology of Sousse)

Abstract

This work introduces a hybrid solar system that integrates photovoltaic (PV), solar thermal, and battery storage components, demonstrating a comprehensive strategy for sustainable energy production. This integrated approach enhances energy reliability and efficiency, supports continuous power supply in isolated habitats, and contributes significantly to environmental resilience and energy autonomy. By leveraging the complementary of PV and solar thermal technomogy, the hybrid system performance is significantly enhanced, leading to improved energy efficiency and reliability. The study's application in the Bejaia region of Algeria, known for its favorable solar irradiance, underscores the practical relevance and suitability of the proposed system for regions with abundant solar resources. Measurement data collected on various days are utilized to identify system parameters, ensuring a robust and data-driven approach to system design and optimization. The use of MATLAB/Simulink simulations allows for detailed analysis of temperature evolution under different solar irradiance profiles, with close alignment to experimental data.

Paper ID 103

Current Sensor Fault Diagnosis of Wind Power system based on DFIG

Authors: chaima gherari (Laboratory of Electrical Engineering and Renewable Energy, University of Souk Ahras)*; Farid Berrezzek (Laboratory of Electrical Engineering and Renewable Energy, University of Souk Ahras); Hicham Zaimen (Laboratory of Electrical Engineering and Renewable Energy, University of Souk Ahras); Khelil Khaled (Laboratory of Electrical Engineering and Renewable Energy, University of Souk Ahras)

Abstract

The paper aims to present an innovative diagnostic approach for identifying faults in the current sensors of wind turbines equipped with doubly fed induction generators

(DFIG). Given the critical reliance on precise current sensor measurements for maintaining control stability, sensor failures can result in significant operational disruptions and increased maintenance costs. The primary goal of the proposed method is to detect, locate, and isolate single sensor faults within the rotorside converter. This aim is achieved through the application of an Unscented Kalman Filter (UKF) organized under a simplified observer scheme, utilizing a nonlinear model for the rotor side. By generating residuals from the comparison between UKF estimates and actual sensor readings, the method effectively identifies faulty sensors, even in the presence of nonlinearity due to wind fluctuations and current coupling issues. The findings demonstrate the effectiveness of this approach in enhancing the reliability of sensor diagnostics, essential for sustaining the performance and stability of the wind turbine system.

Paper ID 105

Sensor-Driven Real-Time Obstacle Detection for Agricultural Drone Spraying Systems

Authors: Ahmed LALLAL (UMMTO)*; Sabrina MOKRANI (UMMTO); Tassadit SADOUN (UMMTO); Mehammed DAOUI (UMMTO)

Abstract

The injection of pesticides into agriculture fields using drones represents a significant advancement in precision agriculture, offering an efficient and targeted application of chemicals while reducing human exposure to harmful substances. These drones are equipped with various sensors that allow them to monitor crop health and apply pesticides accurately in affected areas in real time. However, a major challenge in this technology is detecting and avoiding obstacles such as trees, poles, wires and even humans in the field. Obstacle detection and movement control are major concerns in mobile robotics, especially when autonomous navigation is involved in complex environments. Although current sensor-based technologies, such as LiDAR and radar, provide high accuracy, their high cost and complexity hinder their implementation in resource-constrained platforms such as drones. Moreover, current systems available today use just one category of sensors, which could lead to limited coverage and reliability when for instance, obstacles are not in front but rather beside the drone. This work addresses these concerns by presenting a multi-sensor approach that utilizes ultrasonic sensors, gyroscopes and magnetometers positioned to cover all spaces around the drone. The system can precisely estimate the distance, the angle and the size of obstacles, which enhances movement coordination and obstacle avoidance to a level comparable with natural biological systems. In this paper, we present a new coordination navigation system with obstacle detection based on biological

behavior, we detail the hardware and software components used in our data fusion system and then we present the details of how we developed it.

Paper ID 106

Cold plasma-based methane dry reforming for hydrogen production

Authors: Abir Azara (CDER)*; Khadidja Khodja (CDER)

Abstract

Methane dry reforming (DRM) reaction, which converts two major greenhouse gases, methane and carbon dioxide, into valuable synthesis gas (syngas) rich in hydrogen, is considered an effective way to mitigate carbon emissions. However, DRM is a highly endothermic reaction and it requires a significant input of energy. Non-thermal plasma has emerged as a promising alternative option, enabling the production of hydrogen via DRM at room temperature and atmospheric pressure. This study employs a zero-dimensional (0D) model to investigate the impact of methane/carbon dioxide ratio on methane and carbon dioxide conversions and hydrogen yield. The optimal ratio has been chosen to study the temporal evolution of densities and selectivities of DRM reaction various species within the plasma reactor.

Paper ID 107

Coupled Magneto-Mechanical Modeling of a Marine Wave Energy Recovery System

Authors: Bachir Ouartal (LATAGE Laboratory, Mouloud Mammeri University of Tizi-Ouzou)*; Meziane Hamel (LEMI Laboratory of Energy and Mechanical Engineering M'Hamed Bougara University of Boumerdès); Mustapha Zaouia (LATAGE Laboratory, Mouloud Mammeri University of Tizi-Ouzou); Ratiba Fellag (Robotics and Industrial Automation laboratory Advanced Technology Development Center); Riad Moualek (LATAGE Laboratory, Mouloud Mammeri University of Tizi-Ouzou); Ahmed Nait Ouslimane (Electrical Engineering Dept Mammeri University of Tizi-Ouzou)

Abstract

This study presents a coupled magneto-mechanical modeling approach applied to a wave energy conversion system based on a Tubular Linear Permanent Magnet Generator (TLPMG). The device is designed to efficiently and sustainably convert the kinetic energy generated by the

vertical motion of ocean waves into electrical energy.
The magnetic field is formulated using both scalar and vector magnetic potentials and solved through the Finite Element Method (FEM). Simultaneously, the mechanical behavior of the buoy is described using a hydrodynamic model of wave-induced motion. The interaction between the mechanical and electromagnetic subsystems is ensured via the magnetic force, which enables dynamic coupling between the two domains.
The model was developed in MATLAB/Simulink, leveraging the Simscape Power Systems (SPS) library to simulate the entire energy conversion chain. This includes the generation of three-phase electromotive forces, their rectification using a three-phase diode bridge, and the transfer of the resulting DC power to a resistive load. Voltage and current sensors allow real-time measurement of the output active power.
Simulation results highlight the time evolution of displacement, velocity, induced electromotive force, and generated electrical power. The analysis confirms the effectiveness and relevance of the proposed configuration for wave energy conversion, offering a solid foundation for future optimization studies.

Paper ID 109

Intelligent Hysteresis Current Control Based on Support Vector Machine for SAPF Integrated PV System Under Nonstationary Harmonics

Authors: Mustapha Meraouah (University of Tiaret)*; Faiza Kaddari (Higher School of Electrical and Energy Engineering of Oran); Said Hassaine (University of Tiaret); Youcef Mihoub (University of Tiaret); Sandrine Moreau (University of Poitiers)

Abstract

Advanced intelligent techniques based on machine learning have been proposed as fast-responding mechanisms to enhance power quality in shunt active power filters integrated with photovoltaic systems (SAPF-PV), particularly under non-stationary harmonics caused by variable nonlinear loads. This paper presents an adaptive hysteresis band current controller using a support vector machine (SVM-AHBCC) to generate switching pulses for voltage source inverters (VSIs). The proposed SVM-AHBCC was implemented and validated using MATLAB/Simulink, with performance compared against fixed hysteresis current control (FHBCC) and adaptive HCC (AHBCC) based on analytical methods. Simulation results demonstrate that the SVM-AHBCC maintains total harmonic distortion (THD) consistently below 3.08%, while ensuring reactive power compensation and full photovoltaic power injection into the grid without the need for

complex computations. These results confirm the robustness, adaptability, and effectiveness of the proposed intelligent controller under non-stationary operating conditions.

Paper ID 112

Fruit anomaly detection and manipulation using a vision-guided autonomous aerial manipulator

Authors: SOUIER Bidjad (University of Tlemcen)*; choukri Bensalah (University of Tlemcen); Rida Mokhtari (Ecole superieure en sciences appliquees de Tlemcen); Amal Choukchou (University of tlemcen); Mohamed Abderrahim (University Carlos III of Madrid)

Abstract

This study presents a vision-based unmanned aerial manipulator (UAM) system designed for precision agriculture applications, specifically targeting the detection and removal of rotten apples in large-scale orchards. A dataset of healthy and rotten apples was collected under varying environmental conditions and augmented to enhance model robustness. The system employs a YOLOv8-based object detection model to identify and localize target fruits. Subsequently, the UAM is guided visually to perform grasping operations, supported by integrated kinematic and dynamic control strategies. The proposed methodologies were evaluated in a simulated environment using MATLAB/Simulink, demonstrating effective detection, localization, and manipulation capabilities. Index Terms— Unmanned aerial manipulator, YOLOv8, agriculture precision, IBVS, Inverse kinematics, and dynamic control.

Paper ID 114

Detection of Silicone Oil Concentration Using a Two-Dimensional Photonic Crystal Sensor

Authors: Sarra Bendib (mohammed elbachir elibrahimi university)*; Saidani Okba (mohammed elbachir elibrahimi university); Yousfi Abderrahim (mohammed elbachir elibrahimi university); Nadhir Djeffal (Mohamed Elbachir Elibrahimi University)

Abstract

Silicone oil is widely used in biomedical applications such as intraocular tamponade agents in retinal surgery, lubricants in implantable devices, and insulating layers in microfluidic systems. Monitoring its concentration is critical for ensuring

patient safety, maintaining device performance, and enabling precise control in lab-on-chip platforms. In this work, we propose and analyze a two-dimensional (2D) photonic crystal (PhC) sensor for detecting silicone oil concentration in aqueous media. The proposed structure leverages the sensitivity of defect-mode resonance to refractive index changes to achieve high sensitivity and specificity in detecting varying silicone oil concentrations. Simulations demonstrate that the resonant wavelength shifts proportionally with silicone oil volume fraction, providing a reliable optical signature for real-time monitoring.

Paper ID 115

Energy Management of a PEMFC/Battery Electric Vehicle Using a State Machine Strategy

Authors: Khoudir KAKOUCHE (Université de Bejaia) *; Toufik REKIOUA (Université de Bejaia); Djamila REKIOUA (Université de Bejaia); Amira SLIMANI (University of Biskra); Zahra MOKRANI (Université de Bejaia); Mohammed Amine SOUMEUR (University of Bechar)

Abstract

The demand for cleaner transportation and reduced dependency on fossil fuels is driving the growing integration of fuel cell hybrid electric vehicles (FHEVs) across the globe. This paper presents an energy management strategy based on a state machine control (SMC) approach for a hybrid electric vehicle. The studied FHEV system includes two energy sources: a proton exchange membrane fuel cell (PEMFC) as the primary source and a lithium-ion battery as an auxiliary source, both connected to the DC bus through DC-DC converters. The proposed state machine-based control strategy aims to ensure efficient propulsion power, effectively regulate the energy flow between the power sources and the traction system, and reduce both fuel consumption and battery discharge. The SMC approach is evaluated and compared to an energy management strategy based on equivalent consumption minimization strategy (ECMS), using the urban dynamometer driving schedule (UDDS) cycle. Simulation results demonstrate that the proposed SMC strategy meets the power demand, mitigates DC bus voltage fluctuations, minimizes hydrogen consumption, and improves the response time.

Paper ID 117

Co-Simulation and Modeling of WT-AFPMSG Based on Ansys Software and MATLAB/Simulink for Wind Energy application

Authors: Lina Bouhafs (University of Bejaia)*; Salah TAMALOUZT (Université Abderrahmane mira Bejaia); Mustafa Ergin ŞAHİN (Recep Tayyip Erdoğan University); Ahcen BOUZIDA (University Ali Mohand Oulhadj)

Abstract

As global demand for clean and sustainable energy rises, wind turbines have become as a crucial solution in the transition to renewable energy sources. In this context, the Axial Flux Permanent Magnet Synchronous Generator (AFPMSG) is particularly noteworthy for its compact design, high power density, and efficiency, making it an attractive option for wind energy conversion systems. Its axial structure is especially advantageous for integration with wind turbines, particularly in applications where space and weight constraints are significant. This article details the comprehensive modeling and simulation of a wind turbine system based on an AFPMSG. The modeling process was conducted using ANSYS software for finite element analysis (FEA), beginning with the creation of a 2D model in Maxwell through RMxprt, where the geometric and electromagnetic design of the AFPMSG was established. Concurrently, MATLAB/Simulink was employed to model the wind turbine and implement a Maximum Power Point Tracking (MPPT) system to optimize energy extraction. To ensure a realistic and efficient simulation, a co-simulation model was developed within the Twin Builder environment, integrating Maxwell, Twin Builder, and Simulink. This integration facilitated continuous data exchange among all components, ensuring dynamic interaction between the mechanical and electrical aspects of the system. The simulation studies conducted with the electromagnetic analysis software Maxwell provided more realistic modeling and validated the data obtained. Furthermore, the co-simulation feature offers an effective opportunity for performance testing in conjunction with the electromagnetic modeling of power electronics circuits.

Paper ID 118

Enhanced Fault-Tolerant Harmonic Compensation in Grid-Connected PV Systems: A Comparative Study of Analog Filters for Cascaded Multilevel Inverter Control

Authors: sabrina nacef (universite de bejaia)*; Haroune AOUZELLAG (universite de bejaia); Bessam AMROUCHE (universite de bejaia)

Abstract

This paper investigates the impact of analog filter selection on harmonic compensation in a fault-resilient control strategy for a seven-level Cascaded H-Bridge (CHB) inverter interfaced with a photovoltaic (PV) system connected to the grid. The proposed control framework ensures current

regulation and synchronization under inverter submodule faults by injecting compensation voltages in the dq reference frame. Two analog filters—Butterworth and Chebyshev Type I—are compared in terms of their dynamic response, total harmonic distortion (THD), group delay, and steady-state accuracy. MATLAB/Simulink simulations demonstrate that both filters effectively restore power quality following faults, with the Butterworth filter offering superior smoothness and phase characteristics, while the Chebyshev filter provides sharper frequency attenuation.

Paper ID 119

Enhanced Direct Current Control in Grid-Following Inverters Using Open-Loop Synchronization and PR Regulator for Renewable Energy Integration

Authors: LAKHDER AYHAR (Univeristy of Tiaret)*

Abstract

In order to guarantee stable power injection during the integration of renewable energy sources into power grids, grid-following inverters (GFLs) require strong control strategies. This study suggests an improved direct current control technique for GFLs that combines a proportional-resonant (PR) current regulator with open-loop synchronization to enhance power quality and dynamic performance. The open-loop synchronization simplifies grid current tracking and removes stability problems in weak grids, in contrast to traditional techniques. The PR regulator ensures selective harmonic compensation and accurate current reference tracking with zero steady-state error. MATLAB/Simulink simulations are used to assess the suggested control scheme in the presence of grid disruptions. The findings show improved robustness and superior transient response. The technique's ability to sustain grid compliance in a variety of scenarios demonstrates its potential for dependable integration of renewable energy.

Paper ID 121

Formal Concept Analysis for Knowledge Extraction and Optimal Configuration Selection in Photovoltaic Installations

Authors: Zina AIT YAKOUB (Mouloud MAMMER University)*; Ali BECHOUCHE (Mouloud MAMMERI University); Djaffar OULD ABDESLAM (Haute Alsace University)

Abstract

Photovoltaic (PV) solar energy is one of the most important renewable energy sources in the transition from conventional energy to sustainable energy. The structure of PV power generation systems is considerably complex due to the numerous components and their complex interactions, which are further influenced by fluctuating environmental conditions. Assessing these interactions and their impact on system performance and reliability remains a major challenge. This paper presents formal concept analysis (FCA) as a systematic approach for modeling, exploring, and extracting knowledge from data related to PV installations. FCA enables the identification of object groups sharing common attributes and the extraction of reliable implication rules. Therefore, this approach facilitates understanding the factors that influence the stability and efficiency of PV installations, thereby contributing to their optimization and enhanced risk management.

Paper ID 122

Recent Advancements in Energy Management for Hybrid Renewable Energy Systems

Authors: Fayçal HASSAINI (université of Béjaia); said aissou (université of Béjaia)*; Ali BERBOUCHA (université of Béjaia); Elyazid AMIROUCHE (université of Béjaia); Yanis HAMOUDI (université of Béjaia); Houssam DEBOUCHA (université of Béjaia); Abdelhakim BELKAID (université of Béjaia)

Abstract

Given the critical need to reduce greenhouse gas emissions and decrease reliance on fossil fuels, the acceleration of the transition to a sustainable energy model is now more critical than ever. Energy derived from renewable sources such as solar, wind, hydropower, and biomass provide a prospective means of meeting energy requirements while significantly mitigating adverse environmental consequences. Nevertheless, the shift towards renewable energy is not without obstacles, notably the inherent intermittency of certain resources. A potential strategy to mitigate this challenge involves the deployment of complementary hybrid renewable energy systems (HRES), which integrate diverse renewable energy sources to compensate for their individual operational constraints. The incorporation of hybrid renewable energy systems facilitates the balance of electrical power supply and demand, concurrently achieving a gradual reduction in the inherent limitations of renewable energy generation. Nevertheless, the amalgamation of diverse energy sources alongside energy storage solutions introduces complexities in energy management strategies. This paper presents a comprehensive literature review of energy management in

hybrid renewable energy systems, synthesizing findings from various research works. The paper includes a discussion of diverse system architectures, control methodologies, and optimization algorithms. Furthermore, it examines the role of energy management systems in enhancing the stability, reliability, and resilience of HRES, while also considering the minimization of operational expenses and other economic factors.

Paper ID 125

Unbalance fault detection in an IoT-Connected Motor Network Using Artificial Neural Networks

Authors: Massine GANA (Mouloud Mammeri University)*; Zakia CHELLI (Mouloud Mammeri University); Rafik SADDAOUI (Mouloud Mammeri University)

Abstract

This paper presents the design and implementation of a low-cost integrated system for the preventive detection of imbalance faults in a network of interconnected induction motors using Internet of Things (IoT) technologies. The system monitors two key parameters in real time (vibration and temperature) via non-invasive sensors. These signals are collected and transmitted to an ESP32 microcontroller, which forwards the data to the ThingSpeak cloud platform for centralized monitoring and communication between machines. A graphical user interface (GUI) enables remote visualization of motor status, and alerts are generated automatically when predefined thresholds are exceeded. A lightweight artificial neural network (ANN), implemented on the ESP32 board, performs real-time diagnosis of motor health every 15 seconds. To enhance the quality of vibration data and reduce the impact of sensor noise, a Weighted Moving Average (WMA) filter is applied. This filter offers a computationally efficient and adaptive smoothing method, well suited for embedded systems, by emphasizing recent measurements while attenuating fluctuations. The proposed system ensures high motor availability by enabling timely, accurate fault detection and early intervention. Experimental validation demonstrates the system's effectiveness in distinguishing faulty motors from healthy ones, making it applicable to a broad range of industrial contexts, including hydraulic pumps and wind turbines.

Paper ID 126

Ultra Wideband Hybrid-Shaped Dielectric Resonator Antenna Using (RE-BaTiO3) for Modern Wireless Communication Applications

Authors: Abdelhalim Brahimi (Mohamed el Bachir el Ibrahimi university)*; Rachid Chelghoum (University Mohamed El Bachir El Ibrahimi); Nacerdine Bourouba (University Mohamed El Bachir El Ibrahimi); Martínez Jiménez Juan Pablo (Universidad de Zaragoza); Nacerdine Bouzit (University Ferhat Abbas Sétif 1, Sétif); Raouf Zerrougui (University Mohamed El Bachir El Ibrahimi); Abderrahim Yousfi (University Mohamed El Bachir El Ibrahimi); Okba Saidani (University Mohamed El Bachir El Ibrahimi)

Abstract

This work centers on the development of dielectric resonator antennas (DRAs) using binary composite materials made from epoxy resin (RE) and barium titanate ($BaTiO_3$ or BT). The composite samples are prepared under standard environmental conditions, specifically at room temperature and atmospheric pressure. Their dielectric properties are evaluated using the time domain spectroscopy (TDS) technique. The antenna structures are modeled, simulated, and fine-tuned utilizing the Ansys HFSS electromagnetic simulation software. The CDRA involves a design comprising two identical resonators, each combining a rectangular and a cylindrical shape of equal height. This design demonstrates ultra-wideband performance, achieving a 97% relative bandwidth spanning from 6 GHz to 17.32 GHz. Additionally, it supports dual-band circular polarization (axial ratio < 3 dB), with operational bands extending from 9.62–10.14 GHz and 16.74–16.94 GHz. The main objective of this study is to propose innovative antenna configurations suited for modern wireless communication systems.

Paper ID 128

Stabilizing Photovoltaic Output Using a Controlled Ćuk Converter Topology

Authors: Mohamed Kaouane (UMBB)*

Abstract

This paper presents the design and simulation of a DC-DC Ćuk converter tailored for photovoltaic (PV) energy conversion systems. Due to the inherent variability of photovoltaic output—primarily influenced by fluctuating atmospheric conditions—there is a critical need for robust power transfer mechanisms to prevent overvoltage and conversion failures. To address this, a closed-loop Ćuk converter is proposed, designed to ensure fast dynamic response to input variations and to enhance the overall efficiency of power conversion. The converter aims to maintain a stable output voltage at a predetermined level, regardless of irregularities in the input power source. Both open-loop and closed-loop configurations are investigated under varying input conditions to evaluate system performance and validate the proposed control strategy.

Simulation results, conducted using MATLAB/Simulink, demonstrate the effectiveness of the converter in maintaining output voltage stability despite rapid fluctuations in input parameters, confirming its suitability for PV applications.

Paper ID 129

A Space Vector Modulation Scheme for Five-Phase to Three-Phase Indirect Matrix Converter for a Wind Power Application

Authors: Celia MEHANAOUI (A.Mira Béjaïa)*; Sifoura Mezhoud (A.Mira Béjaïa); Ahmed Azib (A.Mira Béjaïa); Nabil Taib (A.Mira Béjaïa)

Abstract

The main objective of variable-speed wind energy conversion systems is to adapt the variable frequency generated by the turbine to the constant grid frequency (50 Hz), while ensuring a balanced three-phase system in terms of voltage and current, and maintaining an optimal power factor typically unity on the grid side. In this context, this paper presents the design of a non-square five-to-three phase indirect matrix converter intended for such applications. The converter's topology is first introduced, followed by a detailed description of the employed control strategy, namely the zero-current space vector modulation technique. Finally, simulation results obtained through MATLAB/Simulink and PSIM co-simulation validate the effectiveness and high performance of the proposed system.

Paper ID 130

Improved Funnel Control Strategy with PI Regulation for Wind Energy Systems for Maximum Power Point Tracking

Authors: Zaina AIT CHEKDHIDH (Mouloud Mammeri University of Tizi-Ouzou: Tizi Ouzou, DZ)*; Aghiles Ardjal (Université Mouloud Mammeri de Tizi-Ouzou : Tizi Ouzou, DZ); Maamar Bettayeb (Sharjah University)

Abstract

This paper presents a control strategy for variablespeed wind turbines based on the Funnel Control method combined with a PI regulator. A scaling factor is introduced to limit the control signal amplitude and improve system stability. A complete model of the wind turbine is developed and

implemented in MATLAB/Simulink. A realistic turbulent wind profile is used to evaluate the controller's performance through simulation. Comparative results between the standard Funnel Control, PI-Funnel without scaling, and PI-Funnel Control with scaling show improved tracking accuracy, reduced control effort, and strong disturbance rejection. The controller ensures fast and stable response while maintaining the error within predefined boundaries, confirming its potential for real-world applications.

Paper ID 131

Thermal aging effects on the electrical, mechanical and physicochemical properties of LDPE power cables insulation

Authors: Slimani Ferhat (Université de Tizi-ouzou)*

Abstract

The effects of thermal aging on the mechanical, electrical and physicochemical properties of low-density polyethylene (LDPE) cable insulating materials have been reported in this work. LDPE samples of 2mm thickness have been subjected to thermal constraint at temperature of 90°C for total aging duration of 5000 h. Then the dielectric strength, tensile strength and elongation at break were measured as a function of aging time. In addition, the structural modifications in LDPEs were verified using Fourier transform infrared (FTIR) spectroscopy. Electrical and mechanical evolutions with aging time, as like as structural modifications in LDPEs, clearly showed that thermal constraint leads to significant changes in the polymer.

Paper ID 134

Prediction of a Tunnel Greenhouse Relative Humidity Using Artificial Neural Network

Authors: Salah BEZARI (Applied Research Unit in Renewable Energies)*; Asma ADDA (University Center of Tipaza); Sidi Mohamed El Amine BEKKOUCHE (Applied Research Unit in Renewable Energies)

Abstract

To guarantee a better food product, technological intervention in the field of agro-systems has become important and almost necessary, particularly in solar greenhouses. The knowledge of the greenhouse system conditions and properties, both geometrical and physical, should determine

instantly, the response behaviour of the greenhouse microclimate. In this paper, an artificial neural network (ANN) was developed and used to predict the relative humidity inside the greenhouse for 10 days. The model database was collected from actual greenhouse climate data in the absence of vegetation in the Ghardaïa region of Algeria. Global solar radiation flux, temperature and external humidity relative are kept as relevant inputs of the time series model. From the result, the prediction of greenhouse relative humidity results simulated using the developed ANN model was strongly correlated with the experimental data (R=0.993). Therefore, the proposed MLP Back Propagation Neural Network model with the developed structure can perform good predictions with the least error of 1.445 and 1.026 for RMSE and MAE respectively. The comparison between the obtained results and the experimental results indicates that the ANN method is suitable for predicting greenhouse climate data.

Paper ID 135

Dynamic Performance Evaluation of a Dual-Star Induction Machine Fed by an Indirect Matrix Converter

Authors: Sifoura MEZHOUD (université de Bejaia)*; Celia MEHANAOUI (université de Bejaia); Ahmed AZIB (université de Bejaia)

Abstract

This paper presents the modeling, control, and simulation of a Double Star Induction Machine (DSIM) driven by an Indirect Matrix Converter (IMC). The IMC architecture comprises a three-phase input rectifier stage followed by two independent inverter stages, linked via a floating DC bus. This configuration enables bidirectional power flow, improved system compactness, and high-quality input/output waveforms, eliminating the need for bulky electrolytic capacitors. The DSIM topology is particularly advantageous due to its inherent fault tolerance, reduced torque ripple, and suitability for high-performance applications such as electric propulsion in small marine vessels. To achieve precise torque and flux regulation, a Direct Torque Control (DTC) strategy is implemented and tailored to the dual-inverter structure. The paper delivers an in-depth analysis of the power conversion system, modulation strategy, and DTC algorithm. Simulation results validate the effectiveness of the proposed drive system in terms of dynamic performance, torque response, and robustness against load and supply variations.

Paper ID 136

Study and development of methodology for dimensioning photovoltaic systems (PVS)

Authors: Leonardo Kunen (UNISATC)*; André Tavares (UNISATC); Breno Carvalho (UNISATC); Franciele Ronchi (UNISATC)

Abstract

Coal mining in the southern region of Santa Catarina, Brazil, has generated several degraded areas over the years. Due to the Coal Civil Public Action (Coal's CPA), the owners of these lands must carry out environmental recovery of impacted zones. Based on this, one proposal is to implement photovoltaic plants in these locations, therefore, a methodology was developed using QGIS software and Python language to accurately estimate the capacity of the plant based on these projections. The methodology was applied in an 0.31 km² area in the city of Criciúma, totaling an installed capacity of 32.8 MWp and an annual generation of 39.66 GWh. To verify the methodology, the Sam Advisor Model (SAM) software was used, which generated only a difference of 11.1%, validating the methodology. Finally, a comparison was made with a photovoltaic plant dimensioning carried out for the same area in 2017, allowing for making it possible to verify significant technological improvements in photovoltaic modules.

Paper ID 138

Design and Development of a Piezoelectric Shoe Using Lead-Free Composite Materials for Mechanical Energy Harvesting

Authors: Zakia CHELLI (Mouloud Mammeri University)*; Massine GANA (LARI Laboratory, FGEI, UMMTO Algeria); Yacine BAGHDADI (Mouloud Mammeri University (UMMTO)); Abdel Madjid DJIDDA (Mouloud Mammeri University (UMMTO)); Malika SAIDI (LCAGC, UMMTO); Hakim ACHOUR (LCAGC, UMMTO)

Abstract

The present study explores a renewable energy harvesting approach based on the mechanical energy generated during human walking. The proposed system employs flexible piezocomposite films embedded in footwear to convert biomechanical movements into electrical energy in a clean and sustainable manner. A significant challenge in the field of portable power systems is the reliance on conventional batteries, which are constrained by limitations including storage capacity, lifespan, and physical size. In order to overcome this limitation, a prototype of a piezoelectric energy harvester capable of recharging batteries through an optimized configuration

of piezocomposite films connected in both series and parallel is presented. This configuration increases both output voltage and current. The material utilized for the nanogenerator comprises a polyurethane (PU) matrix strengthened with synthetic, lead-free ferroelectric particles, bearing the chemical composition ($(Na_{0.535}, K_{0.48})_{0.966}Li_{0.058}Nb_{0.9}Ta_{0.1}O_3$), designated as NKLNT. This work contributes to the development of self-powered, environmentally friendly systems for sustainable wearable electronics.

Paper ID 140

Energy management of a smart district using the neural predictions and predictive control model (MPC)

Authors: Ouchefoun Zoulikha (LSEI)*

Abstract

In this article, we will conduct an optimized energy management study for a smart neighborhood that integrates renewable energy sources (solar and wind) with storage systems (batteries and vehicle-to-grid technology), alongside residential and commercial loads, all connected to the grid. The goal is to develop a robust model for optimal energy management by employing artificial neural networks (ANN) to forecast residential and commercial energy demand based on time. These predictions are essential for optimizing energy production, real-time import and export, and for implementing model-based predictive control (MPC) to minimize costs and enhance energy efficiency. The results demonstrate that this model significantly improves renewable energy management, reduces dependence on the central grid, and promotes sustainable energy use while lowering costs associated with energy imports.

Paper ID 141

Direct Power Control Technique for Wind Power Generation System based on a Double Stator Induction Generator (DSIG)

Authors: Fatma Lounnas (Université de Tizi Ouzou)*

Abstract

In the context of variable-speed wind energy systems, the double-stator induction machine appears to be a viable alternative to the conventional doubly-fed induction machine. This

configuration preserves the advantages of the wound rotor configuration, such as controllability and efficiency while offering a brushless design, which develops system robustness, operational reliability, and significantly reduces maintenance requirements. This research focuses on the implementation of a direct power control strategy for a wind turbine energy system a based on a Double Stator Induction Generator (DSIG). To achieve effective decoupling of power components, a stator flux-oriented control strategy is employed. A proportional-integral control structure is then formulated to ensure dynamic performance and steady-state accuracy. The proposed control methodology is implemented and validated through detailed simulations performed using MATLAB/Simulink environment. The obtained results demonstrate the efficiency, stability, and performance of the developed control strategy under varying operating conditions of wind speed.

Paper ID 142

Comparative numerical study of multilayer walls with and without phase change materials for enhanced thermal performance

Authors: ASMA bouterfif (constantine university)*; Farid Mechighel (Badji Mokhtar - Annaba University)

Abstract

To evaluate the impact of PCM integration This study presents a comparative numerical analysis of two multilayer wall configurations subjected to identical thermal boundary conditions: a conventional three-layer wall (Wall A) and a five-layer wall (Wall B) integrating a paraffin-based Phase Change Material (RT27). Simulations were conducted over a full 24-hour cycle using a two-dimensional transient heat transfer model in COMSOL Multiphysics. Results demonstrate that the PCM-integrated wall (Wall B) significantly reduced interior surface temperatures, with values remaining near 286 K during peak external heating, compared to over 294 K in the reference wall. The PCM layer effectively delayed heat penetration by maintaining a stable temperature within its melting range (26–28 °C), absorbing latent heat and moderating interior temperature fluctuations. Temperature contour plots and average temperature evolution confirmed that Wall B exhibited improved thermal inertia, a slower heating rate, and extended thermal buffering. These findings highlight the potential of PCM-enhanced envelopes to improve passive thermal regulation and reduce peak cooling loads in buildings exposed to dynamic

environmental conditions. Keywords: Phase Change Material (PCM), RT27 Paraffin, Building Envelope, Thermal Energy Storage, Heat Transfer Simulation.

Paper ID 145

Forecasting Electrical Outages in Adrar, Algeria: Towards a Smart Energy Management System

Authors: Samia Bentaieb (University of Ain Temouchent)*; Driss Nehari (University of Ain temouchent); Ammar Neçaibia (Centre de Developpement des Energies Renouvelables ´ CDER, Adrar); Messaoud Hamouda (University of Adrar)

Abstract

In this study, we present a predictive modeling framework for anticipating power outages using temporal, meteorological, and historical outage data. The proposed methodology gathers aggregate temporal and contextual data from multiple sources, and then engineers features based on time, binary indicators, and derived features. A Random Forest classifier is developed using a train-test partition and the model robustness is established through cross-validation. The model is designed to predict outages based on patterns in the energy consumption and environmental conditions. The performance of the model is evaluated using several metrics, it reached an accuracy of approximately 99%, with precision, recall, and F1-scores all exceeding 98%. The findings of this study provide evidence that supports the proposed approach for anticipating power outages to create smarter grid management and better reliability in power systems.

Paper ID 146

Design and implementation of a modular cold storage system

Authors: Bouchra Lahlou (ENPO)*; Latefa Ghomri (Abou Bakr Belkaid University of Tlemcen); Mohammed Sari (ENPO)

Abstract

In Africa, food wastage is largely due to the lack of cold storage facilities. Cold storage is a highly energy-intensive sector, therefore, innovative and energy-efficient solutions are essential.

This paper presents a modular cold storage system that adapts the storage volume to match the

volume of stored products. This is achieved by dividing one storage space into multiple flexible and thermally insulated sections. The system operation is demonstrated through a low-fidelity prototype, and adapted to a full-scale industrial implementation. Simulation results show that the greater the variation in fill rate, the greater the efficiency of the system. In the best-case scenario, the proposed solution achieves an energy saving of 5.3 percent over a five-year period.

Paper ID 147

IoT-based climatic Environment monitoring system Design for a cattle breeding buildings

Authors: Sihem SOUIKI (University of Ain Temouchent)*; Mourad HADJILA (University of Tlemcen); Reda yagoub (University of Ain Temouchent); Abdelillah Boudjella (University of Ain Temouchent); Oussama Ahed Messaoud (University of Ain Temouchent)

Abstract

Our goal is to improve modern technology in cattle breeding through the implementation of automatic control and monitoring systems in cattle farms. The system will provide breeders with an effective means to monitor and manage their livestock buildings through IOT technology to achieve optimal production while minimizing costs. Following this idea, we divided the work into three parts: The first part consisted of constructing a farm-wide climate parameter automatic detection system with wireless connections to a treatment center for real-time remote Monitoring of Climatic Parameter over Time. For the second part, we are creating an Internet-based platform for real-time display and storage of climate parameters including visualization, as well as the visual analysis of these data on the application. For the last part, a prototype of a stable was built so that the system's performance and functionality could be tested.

Paper ID 149

Optimization of Energy Management in a PV–Wind–Battery Microgrid Using PSO in MATLAB

Authors: meziane kaci (université de khemis miliana)*; Hassane Ezziane (Research Laboratory of Electrical Engineering and Automatics LREA, University of Medea, Medea, Algeria); slim Rouabah (Department of Electronic and Communication, Faculty of Sciences and Technology, Djilali Bounaama University of Khemis Miliana, Ain Defla, Algeria); zakaria layate (Department of Electrical Engineering, Faculty of Sciences and Technology, Djilali Bounaama University of

Khemis Miliana , Ain Defla, Algeria); hakim Ait said (Department of Electrical Engineering and Automatic, Faculty of Sciences and Technology, Ahmed Zabana University, Relizane, Algeria); hamou nouri (Department of Electrical Engineering, Ferhat Abbas University, Setif, Algeria)

Abstract

This paper proposes an optimized energy management strategy for a hybrid microgrid comprising photovoltaic (PV), wind energy, and battery storage systems. The goal is to enhance energy autonomy and minimize reliance on the utility grid. A Particle Swarm Optimization (PSO)-based energy management system (EMS) is developed and implemented in MATLAB, and its performance is evaluated against a conventional rule-based control strategy over a 24-hour simulation period with variable residential load. The optimization considers operational constraints, including battery power limits and state-of-charge (SOC) boundaries. Simulation results reveal that the PSO-based EMS significantly reduces grid energy import, improves renewable energy utilization, and maintains system balance more effectively than the rule-based approach. The proposed framework offers a replicable and scalable solution for both academic research and real-world microgrid applications.

Paper ID 151

Performance Assessment of ANN and MLR Models for Predicting NF/RO Desalination System

Authors: Adda Asma (Medea university)*; Salah BEZARI (UREAR/CDER)

Abstract

This study develops and compares artificial neural network (ANN) and multiple linear regression (MLR) models to predict the permeate flow rate of a small-scale NF/RO desalination pilot plant. The experimental dataset includes measurements of time, feed pressure, feed temperature, feed flow rate, feed conductivity and permeate conductivity; the target variable is permeate flow rate. Data were preprocessed (outlier screening and normalization) and split into training (80%), validation (10%) and test (10%) subsets. A feed-forward ANN with a (6–17–1) architecture was trained using the BFGS quasi-Newton algorithm (trainbfg); an MLR model was used as a baseline. Models were evaluated using the correlation coefficient (R), root mean square error (RMSE) and mean absolute error (MAE). The ANN model substantially outperformed the MLR baseline showing higher R and markedly lower RMSE and MAE. These results demonstrate that the ANN provides reliable and accurate predictions of permeate flow rate and is suitable to support monitoring and predictive control of NF/RO systems.

Paper ID 152

Renewable Energy Deployment Efficiency: Analyzing Algeria's Achievement Gap and Optimization Strategies

Authors: Elmer Arellanos-Tafur (Universidad Continental)*; Marcelo Damas-Niño (Universidad Nacional del Callao)

Abstract

Algeria's renewable energy initiative reached only 15.68% of its projected capacity by 2020 (686 MW of the 4,375 MW target), placing it among the lowest implementation rates worldwide. This paper examines the technical and institutional constraints contributing to this shortfall using data from Algeria's National Renewable Energy Program (PENREE) and outlines optimization measures to align progress with the updated 22,000 MW objective for 2030. A comparative review with successful renewable programs in peer economies identifies key bottlenecks and introduces a phase-gate implementation framework capable of raising achievement levels to 60–75%. Results show that grid connection delays account for nearly 40% of project disruptions, followed by financing issues (35%) and permitting processes (25%), underscoring structural weaknesses in inter-institutional coordination. Based on official IRENA data, this research delivers the first quantitative evaluation of deployment efficiency for renewable projects in the MENA region and establishes a replicable methodology for assessing large-scale transition programs. While the proposed strategies could substantially accelerate implementation, their effectiveness remains contingent on institutional capacity development and stronger project management practices. Technology-specific outcomes reveal considerable variation: solar PV achieved 13.33% of its target, whereas wind projects reached only 5%. Regional comparisons show unexpected patterns, with remote zones such as Adrar attaining up to 70% success rates, compared to 15% in grid-connected northern areas. These results challenge the prevailing assumption that resource endowment alone determines deployment performance.

Paper ID 153

Daily energy production patterns in medium-scale hydroelectric operations: a longitudinal descriptive study

Authors: Elmer Arellanos-Tafur (Universidad Continental)*; Marcelo Damas-Niño (Universidad Nacional del Callao)

Abstract

The present research addresses the limited documentation of daily energy generation patterns in medium-scale hydroelectric plants within current literature. It analyzes a 14-month dataset (from April 2024 to May 2025) from a representative 4 MW facility in Peru, comprising 404 consecutive daily observations. The temporal variability identified in these records provides valuable insights into broader operational dynamics. Statistical analysis revealed distinct seasonal fluctuations, with an average daily production of 80.70 MWh (σ = 8.04). The coefficient of variation (9.96%) denotes stable operational performance throughout the observation period. Monthly distributions exhibited significant differences, with optimal performance during winter months (mean = 82.38 MWh, CV = 5.67%) and increased variability during summer period (mean = 78.15 MWh, CV = 8.67%). Maximum outputs reached 89.40 MWh and minimum levels reached 11.75 MWh. The interquartile range (79.34–84.90 MWh) indicates concentration of generation near the facility's optimal efficiency envelope. These results suggest that the observed patterns arise from the interaction of hydrological availability, operational scheduling, and maintenance protocols. The empirical characterization provides baseline indicators for comparative evaluations and operational optimization, while emphasizing the necessity of incorporating meteorological variables and multi-facility datasets in future investigations.

Paper ID 154

Statistical Assessment of Commercial Electric Service Quality: A Case Study of ENEL Distribution Company in Peru

Authors: Marcelo Damas-Niño (Universidad Nacional del Callao); Elmer Arellanos-Tafur (Universidad Continental)*

Abstract

This study presents a comprehensive statistical assessment framework for evaluating commercial electric service quality within ENEL's distribution network across Peru. The statistical methodology encompasses rigorous sampling techniques, compliance rate calculations, correlation analyses, and performance benchmarking against National Technical Standards for Electric Service (NTCSE). From an initial population of 812 users, stratified sampling yielded 342 statistically representative participants across industrial, commercial, and residential segments throughout Lima. Statistical evaluation employed SPSS software for descriptive statistics, variance analysis, hypothesis testing, and regression modeling to assess service quality dimensions. The assessment revealed statistically significant compliance rates of 94.8% for

customer treatment ($p<0.001$), 98.1% for infrastructure performance ($p<0.001$), and 96.3% for measurement precision ($p<0.001$). Customer satisfaction correlation analysis demonstrated strong positive relationships ($r=0.73$) with operational compliance metrics. Advanced statistical modeling including machine learning algorithms achieved 89.3% prediction accuracy for service quality patterns. This statistical framework establishes quantitative benchmarks for utility performance evaluation, providing stakeholders with empirically validated metrics that demonstrate measurable relationships between operational compliance and customer satisfaction in developing economy contexts.

Paper ID 155

A Multidisciplinary Systems Engineering Approach to Hybrid Energy Systems Development

Authors: Khaled Bounar (TSI); Salah Badjou (API)*

Abstract

This paper presents a multidisciplinary golden mean systems engineering approach to assessing and designing optimal energy solutions, emphasizing the integration of appropriate renewable energy sources. It highlights the growing economic, ecological, and health significance of transitioning to renewable systems and the need for comprehensive, tailored solutions. A golden mean approach considers all energy sources, storage options, cost-effectiveness, and environmental impacts while analyzing the advantages, limitations, current research status, and future technological trends of various energy technologies. We propose that hybrid systems − combining locally available renewable energy sources such as solar, wind, hydrokinetic, biomass, and geothermal, along with hydrocarbons where necessary − and are adapted to local resources and power demands, offer the most effective and sustainable solutions. Additionally, we explore advanced energy management, storage strategies, and hydrogen integration to enhance grid stability and resilience. Beyond technical considerations, the paper underscores the importance of developing educational programs to train a skilled workforce capable of driving the energy transition and strengthening local economies.

Paper ID 156

Design and Implementation of a Low-Cost Automatic Weather Station Based on the Internet of Things

Authors: SEFIA ATTIA (Université de Tlemcen)*

Abstract

This project consists of the creation of a system for acquiring and displaying measurements from a low-cost automatic meteorological station intended for installations based on renewable energies. It is part of an Internet of Things (IoT) type monitoring strategy. The prototype is energy autonomous and powered by mini-solar panels and Li-Po batteries, via an MCP1700-LDO (Low-Dropout) regulator. Environmental data such as ambient temperature, sunlight intensity, wind speed and direction, UV index, etc., is collected without human intervention by various sensors. The station was placed on the roof of the building dedicated to the research laboratories of the Faculty of Technology of the University of Tlemcen. A Stevenson screen was completely designed and produced by 3D printing to protect the station. Data acquisition and transmission is carried out by an ESP32 card equipped with a Tensilica Xtensa LX6 processor and a WiFi module. This board offers excellent value for money for IoT-based projects. It is programmable with several languages such as C/C++ or Micro-Python, thanks to a variety of libraries. The ThingSpeak platform was chosen to store information collected online via the Internet (Cloud), store it and display it to make it available on a smartphone, tablet or computer.

Paper ID 157

Integrated Geophysical Approach for Groundwater Prospecting

Authors: Khaled Bounar (TSI)*; Doria Kutrubes (Radar Solutions International)

Abstract

This work presents an integrated geophysical approach for groundwater prospecting, by combining geophysical techniques such as Ground Penetrating Radar (GPR), Electrical Resistivity Tomography (ERT), Vertical Electrical Sounding (VES), or gravity surveys to assess the suitability of bedrock and overburden for potable water supply. While each geophysical technique has limitations and may not fully characterize the subsurface conditions on its own, when used together, they provide the most comprehensive characterization of the subsurface.

Paper ID 158

From Grid Following to Grid Forming in PV Grid Tied Single Phase Inverter

Authors: Mourad Zebboudj (Université de Béjaia)*; Syphax Ihammouchen (Université de Béjaia); Toufik Rekioua (Université de Béjaia); Djamila Rekioua (Université de Béjaia); Ali Chebabhi (University of M'sila); Mohammed Said Ouahabi (University of M'sila)

Abstract

This research focuses on photovoltaic systems connected to single-phase inverters operating in two distinct modes: isolated operation using grid-forming inverters (GFMi) and grid-connected operation using grid-following inverters (GFLi). Given the increasing proportion of inverter-based energy sources in modern grids, GFLi systems can contribute to grid frequency stability under normal conditions. However, the primary aim of this study is to address challenges and failures that can occur in the electrical grid, such as disturbances, voltage sags, and distribution blackouts, by employing GFMi technology to supply loads independently during grid outages. The study was conducted using MATLAB/Simulink software, comparing the performance of damped and undamped LCL filters, with the damped configuration demonstrating superior performance. The results confirm the effectiveness of the GFMi system in supplying loads during disconnection from the electrical grid, achieving a THD of 2.63% at the inverter output for islanded operation. For grid-connected GFLi operation, the damped LCL filter achieves a THD of 1.74% for the current injected into the grid, meeting power quality standards.

Paper ID 159

A Low-Cost and Eco-Friendly Humidity Sensor Based on Keratin Thin Film

Authors: hammouche hayat (université mouloud mammeri)*; rabhi saliha (université mouloud mammeri); , DOUANI Rachida (université mouloud mammeri); lamrani nouara (université mouloud mammeri); laghrouche mourad (université mouloud mammeri)

Abstract

In response to environmental and sustainability challenges, the development of eco-friendly materials for sensor applications is gaining increasing interest. Biopolymers derived from renewable resources, such as keratin, present a promising alternative due to their biocompatibility, biodegradability, and low environmental impact. In this study, we report the study of a humidity sensor based on porous amorphous keratin as a function of exposure time and relative humidity (RH). Resistive humidity sensors keratin were fabricated through evaporating

coplanar interdigital gold electrodes. spectroscopy. Hygroscopicity was studied by measuring the resistance of the sensor under various RH. The results reveal a porous, fibrous, and slightly rough structure that facilitates water vapor adsorption, making it suitable for humidity sensing applications, in addition the measured resistance highly depends on the applied bias voltage. Moreover, the response signal against RH is found linear for an applied voltage of 2 V. These findings demonstrate the suitability of keratin as an efficient, sustainable material for environmental monitoring devices

Paper ID 161

Review of smart systems in aquaculture and aquaponics

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Abstract

In this paper, we present a set of works between 2019-2025 in the field of aquaculture and smart aquaculture systems, which witnessed remarkable developments by integrating modern technologies such as artificial intelligence, Internet of Things and cloud computing. The works were based on a set of standards to monitor and automatically control environmental changes in the system and maintain its stability, and the works presented a set of technologies in the field of tracking the growth of crops including fish and plants and enhancing the efficiency of resource management to reduce waste. In addition to works that included proactive prediction of environmental variables, decision support systems for failure analysis, and automated feeder systems, with the aim of developing smart systems that address new challenges and solve previous shortcomings observed in the field.

Paper ID 162

Optimal Distribution Network Reconfiguration for Minimizing Energy Losses and Enhancing Reliability Using Metaheuristics

Authors: anes bouhanik (university of biskra)*; Samir Bouslimani (Higher National School of Renewable Energy, Environment and Sustainable Development); Ahmed Salhi (University of Biskra); Djemai Naimi (University of Biskra); Younes Zahraoui (FinEst Centre for Smart Cities, Tallinn University of Technology, Tallinn, Estonia); Saad Mekhilef (School of Software and Electrical Engineering, Swinburne University of Technology, Melbourne, Australia)

Abstract

This study presents a multi-objective framework for the reconfiguration of radial electrical distribution networks, accounting for hourly load variations across diverse consumer categories using realistic 24-hour profiles. The framework simultaneously minimizes daily technical energy losses J1 and risk-weighted expected interruption costs J2, the latter quantifying the economic impact of outages through line failure rates, repair times, and the Value of Lost Load (VOLL). A unified satisfaction degree DS, derived via sigmoid-based fuzzy normalization with weights of 0.6 for J1 and 0.4 for J2, is adopted to balance efficiency and reliability while ensuring stable convergence. The approach is validated on a modified IEEE 33-bus test system, utilizing four metaheuristic algorithms: Artificial Ecosystem-based Optimization (AEO), Equilibrium Optimizer (EO), Gorilla Troops Optimizer (GTO), and Geometric Mean Optimizer (GMO). Results show that AEO consistently achieves the highest \mathbit{DS} (0.3), reducing daily energy losses to 3011.49 kWh/day and improving minimum bus voltage from 0.9045 pu to 0.9678 pu, outperforming the other methods across all evaluation metrics.

Paper ID 163

Heart Beat IoT: Real-time cardiac monitoring

Authors: SALIHA RABEHI (UMMTO)*; Malika SAIDI (LCAGC); Hayat HAMMOUCHE (Electronique); Nadia SERKHANE (Chimie); Hakim ACHOUR (Electronique); Ahcéne CHAOUCHI (Chimie); Mourad LAGHROUCHE (Electronique); Nouara LAMRANI (Chimie); Mohamed RGUITI (Chimie); Christian COURTOIS (Chimie); Yannick LORGOUILLOUX (Chimie); Mohamed Aymen BEN ACHOUR (Chimie)

Abstract

This project proposes an innovative portable and connected cardiac monitoring system, based on the XD58C sensor (using PPG technology) and the ESP32 microcontroller, enabling heart rate to be measured, processed and transmitted in real time. The device features advanced signal filtering for accurate heartbeat detection, Wi-Fi wireless transmission to a user interface (smartphone or web dashboard), and an optimized power supply for extended autonomy. Its

applications cover telemedicine and cardiovascular risk prevention, as well as monitoring athletes or patients on the move, while demonstrating the potential of low-cost connected objects in e-health. Its strengths include affordability (reduced cost thanks to the ESP32) and portability (compact, stand-alone design). This system represents a step towards medical IoT solutions accessible to the general public

Paper ID 167

Overshoot-Free Speed Control in PMSG Wind Turbines Using a Smooth Sliding Mode Controller

Authors: wassila hattab (university of biskra)*; Amira Slimani (university of biskra)

Abstract

This study presents a Wind Energy Conversion System (WECS) employing a Permanent Magnet Synchronous Generator (PMSG) was studied under the application of a Sliding Mode Controller (SMC) for speed regulation. Initially, a conventional SMC based on the sign function was implemented. While this approach provided robustness, It demonstrated notable limitations, especially in controlling speed overshoot and maintaining dynamic responsiveness under variable wind conditions. To address these challenges, a Smooth Sliding Mode Controller was proposed to replace the conventional SMC. The proposed method improved the system's performance by enhancing speed tracking and eliminating overshoot. This study proposes a reliable and efficient control strategy, rigorously validated through MATLAB/Simulink simulations. The results confirm its effectiveness in stabilizing the system while achieving both steady-state and dynamic performance optimization of the wind energy conversion system.

Paper ID 168

A LADRC-Based Robust Speed Controller for PMSMs in Electric Vehicles With External Disturbance Rejection

Authors: amira Slimani (university of biskra)*; Khoudir KAKOUCHE (university of bejaia); Wassila HATTAB (university of biskra)

Abstract

This study introduces an innovative control strategy based on Linear Active Disturbance Rejection Control (LADRC) for regulating the speed of Permanent Magnet Synchronous Motors (PMSMs) under uncertain system parameters. The research begins with the development of a detailed mathematical model of the PMSM, derived from its intrinsic structural characteristics, providing a solid foundation for control design and analysis. The LADRC framework is adapted to PMSM speed regulation by reformulating it into an integral form to satisfy specific performance requirements. The stability and robustness of the proposed LADRCscheme are rigorously analyzed, demonstrating its ability to ensure optimal performance despite parameter uncertainties and variations. This robustness directly addresses real-world challenges, where system parameters are often un known or subject to change. Furthermore, extensive simulations validate the effectiveness of the proposed approach, showing its capability to achieve accurate and consistent speed tracking even in the presence of incomplete state information or imprecise system models. A comparative simulation study highlights the superior performance of the LADRC controller over conventional proportional integral (PI) controllers, particularly in achieving rapid convergence, eliminating overshoot, and maintaining robustness under disturbances. These results underscore the potential of LADRC to enhance the reliability and performance of PMSMs, marking a significant advancement in motor control methodologies and reinforcing its applicability across a wide range of practical scenarios.

Paper ID 170

Study of a Hybrid PV/Fuel Cell System Dedicated to an Electric Vehicle Charging Station

Authors: Mohamed Lamine Hamida (Mouloud Mammeri University- Electrical Engineering Advanced Technology Laboratory (LATAGE))*; Damya Iamrache (Mouloud Mammeri University); Sarah Maouche (Mouloud Mammeri University); Hakim Denoun (Mouloud Mammeri University); Arezki Fekik (Ecole Centrale de Nantes); Dyhia Kais (Mouloud Mammeri University- Electrical Engineering Advanced Technology Laboratory (LATAGE)); Zoulikha Tebri (Mouloud Mammeri University- Electrical Engineering Advanced Technology Laboratory (LATAGE))

Abstract

This study focuses on the modeling and simulation of a renewable-based multi-source energy system designed to supply an electric vehicle charging station located in a residential area of Tizi Ouzou. The proposed system integrates photovoltaic panels, battery storage, and a fuel cell unit.

By combining multiple energy sources, such systems aim to optimize energy generation, storage, and overall management. Designing such an installation requires a thorough analysis of the site's energy demands, an assessment of the available solar potential, and the implementation of both short-term and long-term energy storage strategies. Using the HOMER Pro simulation software, various system configurations were evaluated to determine the most technically sound and economically viable solution. Simulation outcomes confirm the feasibility of the proposed setup, highlighting its ability to provide a reliable energy supply while minimizing reliance on the conventional power grid. This approach supports the development of sustainable mobility and contributes to reducing the carbon footprint associated with transportation.

Paper ID 171

A Hybrid Electrical and Environmental LSTM Approach for Short-Term Solar Power Forecasting in Algeria

Authors: Rafik Saddaoui (UMMTO); Toufik Toumi (UMMTO); Karim Oudiai (UMMTO); Rachid Zirmi (UMMTO); Hakim Achour (UMMTO); Mourad Laghrouche (UMMTO)*

Abstract

Algeria's exceptional solar irradiation provides a favourable environment for the development of photovoltaic (PV) energy. Nevertheless, the variability of solar energy production poses challenges for grid stability and efficient energy management. This paper proposes an in-depth study that combines electrical modelling of PV cells with long-term memory neural networks (LSTM) to predict PV power generation in the Algerian context. The method combines a mathematical formulation of the electrical characteristics of photovoltaic cells with an LSTM framework applied to real system data, capturing both physical behaviour and temporal dependencies. The model achieves a high level of accuracy in its predictions, illustrating the potential for improving the integration of photovoltaics into the Algerian grid.

Paper ID 172

Wearable Low-Energy RFID-Integrated Vibration Tag for Silent, Long-Term Sleep Apnea Monitoring and Posture Sensing

Authors: Rafik Saddaoui (UMMTO); Samir Aoughlis (UMMTO); Karim Oudiai (UMMTO); Mhenna Nachef (UMMTO); Hamid Hamiche (UMMTO); Mourad Laghrouche (UMMTO)*

Abstract

This paper presents the development of a functional and portable tag sensor aimed at offline detection of apnea incidents with real-time alerts for the patient. The system continually monitors chest and upper abdomen movements via an embedded acceleration sensor. Upon identifying an apnea episode, the event is logged into both the internal EEPROM of the EM4523 transceiver and an SD card, capturing the date, time, and the patient's posture at the time of occurrence. When the patient aligns with the UHF Reader, the tag transmits the stored apnea data, respiration rate, and current body position. The reader, utilizing the modern AS3993 chip, is interfaced with a Raspberry Pi acting as a local server connected to the CLOUD, facilitating internet-based updates for the attending physician. This infrastructure enables data collection from several RFID tags across various locations, allowing comprehensive analysis of apnea events. Once clinicians determine a patient likely suffers from sleep apnea, they contact them by email to retrieve extended data from the SD card, which includes long-term breathing records spanning several months.

Paper ID 173

Enhanced Battery Health Forecasting with Dynamic Thresholds Using Multi Input LSTM Networks

Authors: Rafik Saddaoui (UMMTO); Karim Oudiai (UMMTO); Mhenna Nachef (UMMTO); Hamid Hamiche (UMMTO); Rachid Zirmi (UMMTO); Mourad Laghrouche (UMMTO)*

Abstract

This study introduces a multi-input Long Short-Term Memory (LSTM) network for jointly forecasting battery voltage and classifying state of health (SoH) using voltage, load, and temperature data. The proposed model includes a learnable dynamic threshold mechanism that adapts classification criteria in real time. Experimental evaluation on a real-world dataset shows that our approach significantly outperforms static-threshold models in both forecasting accuracy and SoH classification, offering greater adaptability and robustness across operating conditions.

Paper ID 175

Low Power Energy and Real-Time Localization of Prisoners Inside Correctional Facilities Using Inertial Sensors and Particle Filtering: A Dead Reckoning Approach

Authors: Samir Aoughlis (UMMTO); Rafik Saddaoui (UMMTO); Karim Oudiai (UMMTO); Hamid Hamiche (UMMTO); Brahim Achour (UMMTO); Mourad Laghrouche (UMMTO)*

Abstract

Accurate localization of prisoners within correctional facilities is critical for enhancing security, monitoring inmate behaviour and optimizing operational efficiency. This paper proposes a low-cost, energy-efficient system employing wearable inertial sensors coupled with dead reckoning enhanced by particle filtering for indoor prisoner tracking. Using an ARM-based microcontroller integrated with a tri-axial accelerometer, gyroscope, and magnetometer, the system estimates real-time prisoner positions based on motion dynamics. Particle filtering constrains the trajectories within the facility's floor plan, mitigating drift errors inherent in inertial navigation. Experimental tests in a simulated prison environment show the system achieves an average localization error below 2 meters over typical inmate movement paths. This method reduces reliance on expensive infrastructure, supports continuous monitoring, and facilitates behavioral analysis for anomaly detection. In this study, we proposed a system designed to monitor the behaviour of an inmate. This system can also be easily applied in precision breeding, enabling the development of management systems based on automatic real-time monitoring of animals. This includes monitoring animal production, health and welfare, as well as assessing the environmental impact of farming activities.

Paper ID 178

Comparative Analysis of YOLOv8, YOLOv11, and Faster R-CNN for Multi-Crop Plant Disease Detection

Authors: Gasmi Rim (University Center of Illizi)*; Marwa Chander (University Center of Illizi); Mohamed amine Badache (University Center of Illizi)

Abstract

Plant diseases constitute a major challenge to global agriculture, causing substantial economic losses and threatening food security. Conventional detection methods are often labor-intensive, time-consuming, and unsuitable for large-scale implementation. This study presents a comparative analysis of three deep learning models—YOLOv8, YOLOv11, and Faster R-CNN—for automated detection of plant diseases in corn, wheat, and palm leaves. Unlike previous research that has primarily focused on individual crops or on classification tasks, this work addresses multi-crop disease detection through object detection techniques, evaluating their generalizability and suitability for real-time applications. Experimental results demonstrate that

YOLOv11 achieves the most favorable trade-off between accuracy, precision, and robustness (mAP@0.5:0.95 = 0.69 for corn, 0.682 for wheat, and 0.66 for palm), making it particularly suitable for deployment in real-time smart agriculture systems. YOLOv8 shows advantages in inference speed and compatibility with edge devices, whereas Faster R-CNN provides high recall but is constrained by its computational demands. Overall, this study contributes to the advancement of scalable, AI-driven agricultural monitoring solutions.

Paper ID 179

Numerical Investigation of CsSnCI3 Perovskite Solar Cells Utilizing WS2 and CuSbS2 Transport Layers for Enhanced Efficiency beyond 24%

Authors: ahmed benameur (University Mohamed El Bachir El Ibrahimi)*; Abderrahim Yousfi (University Mohamed El Bachir El Ibrahimi of Bordj Bou Arreridj); Okba Saidani (University Mohamed El Bachir El Ibrahimi of Bordj Bou Arreridj)

Abstract

This work presents an innovative configuration for simulating solar cells using the SCAPS-1D platform. The simulation model integrates advanced charge transport layers, specifically electron transport layers (ETLs) based on WS_2 and hole transport layers (HTLs) using $CuSbS_2$. The designed heterostructure comprising ITO/WS_2/$CsSnCl_3$/$CuSbS_2$/Ag—exhibits outstanding photoconversion efficiency. A omprehensive investigation evaluates the effects of multiple parameters, including the thickness of the $CsSnCl_3$ absorber, ETL thickness, operating temperature, series resistance, and the combined impact of absorber. Simulation results indicate an optimal open-circuit voltage (VOC) of 1.15 V, a short-circuit current density (JSC) of 26.07 mA/cm², a fill factor of 86.35%, and a power conversion efficiency (PCE) of 24.23%, aligning well with prior studies. This detailed simulation study enhances understanding of the key factors influencing perovskite solar cell performance and highlights potential pathways for future improvements.

Paper ID 182

Emerging AI Methodologies in the Renewable Energy Ecosystem: Successes, Challenges, and Future Research Directions (v2)

Authors: Temitope Bobola (University of Hull)*; Temitayo Fagbola (University of Hull)

Abstract

Artificial Intelligence (AI) is transforming the renewable energy sector by enabling intelligent, adaptive, and data-driven solutions across key operational domains. This paper presents a comprehensive review of emerging AI methodologies applied to renewable energy forecasting, real-time grid coordination, energy management, predictive maintenance, and market optimization. Techniques such as machine learning (ML), deep learning (DL), and reinforcement learning (RL) have achieved notable gains in forecast accuracy, system reliability, distributed energy resource (DER) coordination, and economic efficiency. Despite these advancements, widespread adoption is hindered by data quality issues, legacy infrastructure, limited explainability, and cybersecurity risks. This review synthesizes current successes, identifies persistent challenges, and outlines future research priorities—including edge computing, transfer learning, human-in-the-loop systems, and regulatory frameworks—to support the scalable and secure deployment of AI in renewable energy systems. By addressing these barriers, AI can play a pivotal role in accelerating the transition to a resilient and net-zero energy future.

Paper ID 183

Machine Learning for Predictive Maintenance of Electrical Machines: A Review

Authors: TAHER AMRAOUI (National School of Advanced Technologies ENSTA)*

Abstract

The integration of machine learning (ML) techniques with predictive maintenance (PdM) strategies for electrical machines has experienced remarkable advancement between 2021 and 2025, driven by the imperatives of Industry 4.0, IoT proliferation, and the critical need for operational efficiency. This comprehensive literature review synthesizes findings from over 160 peer-reviewed sources, revealing significant paradigm shifts toward hybrid methodologies, multi-modal data fusion, and physics-informed approaches that achieve fault detection accuracies exceeding 95% while enabling real-time implementation [1][2][3].

Paper ID 184

hydrothermal degradation impacts on the properties of PVC cables insulation

Authors: Slimani Ferhat (Université de Tizi-ouzou)*; Aitouazzou Hassene (Université de Tizi-ouzou)

Abstract

Polymers have always played a major role in the insulation of electrical cables and are the subject of numerous studies when exposed to various stresses. Moisture and temperature are the primary factors that degrade the insulating performance of materials, especially when acting together, leading to hydrothermal aging of polymers. In this study, we investigate the impact of hydrothermal aging on polyvinyl chloride (PVC), a material commonly used in medium-voltage cables, in terms of its electrical insulation capabilities. This research focuses on how temperature and aging time influence the evolution of dielectric properties (dielectric loss factor, dielectric constant, and volume resistivity). Degradation at the early stage of aging is mainly caused by the gradual evaporation of the plasticizer. As aging progresses, degradation can be attributed to the breakdown of the stabilizer, followed by a change in color and the release of hydrochloric acid. This process leads to crosslinking of the material and a reduction in sample volume.

Paper ID 185

Predictive Control of DFIG in a Hybrid PV/DFIG/Batt System Supplying a Water Pumping System

Authors: Tarek BOUDJERDA (University of Bejaia)*; Sofia LALOUNI BELAID (University of Bejaia); Salah TAMALOUZT (University of Bejaia)

Abstract

Over decades, the Doubly Fed Induction Generator (DFIG) has been the standard choice for offshore applications due to its notable features, such as the capability to operate across a wide range of wind speeds, and the smaller size of the back-to-back converter. Furthermore, it can control the active and reactive power independently. The stator of the DFIG is connected to the grid, which provides a seamless exchange of active and reactive power with the grid. In Algeria, the microgrid based on the DFIG is a promising solution to address the climate change problems. In this paper, an efficient and reliable structure is designed for a water pumping application, including a PV system, a DFIG driven by a wind turbine, batteries, and a water pumping system based on the induction motor (IM). The IM is controlled by direct torque control. In addition, the back-to-back converter of the DFIG is driven by Finite Control Set Predictive Control (FCS PC). For the Rotor Side Converter (RSC), a novel Predictive Field-Oriented Control (PFOC) is applied and compared to the Field-Oriented control (FOC). On the other hand, the Grid Side Converter (GSC) is controlled by the Predictive Direct Power control (PDPC). A robust energy management is required to ensure the synergy among the components of the proposed structure.

The simulation findings confirm the effectiveness of the proposed control techniques and the accuracy of the energy management algorithm.

Paper ID 186

Seasonal Variability and Performance Optimization of Wind Power Generation: A Comprehensive Study of ENGIE Operations

Authors: Elmer Arellanos-Tafur (Universidad Continental)*; Marcelo Damas-Niño (Universidad Nacional del Callao)

Abstract

This comprehensive study examines wind energy generation patterns exclusively across four ENGIE wind facilities in Peru over a complete annual cycle, from May 1, 2024 to April 30, 2025. A total of 362 days of daily generation data were analyzed, representing 1,119,674 MWh of clean energy production across the portfolio. The research reveals significant seasonal variations in wind power output, with peak generation consistently occurring during Peru's austral winter months (June–September), when atmospheric conditions are most favorable for harvesting. The facilities demonstrated substantial performance heterogeneity, with average daily production ranging from 399 MWh to 1,182 MWh, and capacity factors varying between 25% and 74%. Wind generation exhibited strong correlation with regional meteorological patterns, particularly during the dry season when atmospheric stability enhances predictability. Statistical analysis revealed coefficients of daily output variability ranging from 0.45 to 0.85 across different facilities, underscoring the critical need for complementary storage systems and advanced grid-balancing strategies. The study provides evidence-based insights into optimizing wind farm operations in tropical latitudes and confirms Peru's excellent potential for large-scale deployment. Correlation analysis between facilities reveals moderate to strong statistical relationships (0.45–0.89), highlighting diversification opportunities and portfolio optimization strategies. These findings contribute significantly to understanding wind energy dynamics, offering clear evidence of seasonal dependence, site heterogeneity, and inter-facility synergies, with data-driven recommendations for expanding sustainable energy infrastructure in Peru and similar regions.

Paper ID 188

Anomaly Detection in Datacenter Energy Consumption using an Autoencoder

Authors: Karima OUKFIF (UMMTO)*

Abstract

Optimizing energy consumption is one of the most challenging topics in datacenter infrastructures. Identifying unexpected high resource utilization led to detecting energy consumption anomalies. The purpose of this work is to detect deviant energy consumption behaviors characterized by unusual usage of resources. We propose an artificial intelligence model for unsupervised anomaly detection. The model is constructed as a Robust Autoencoder with an optimized architecture of layers. We performed the assessments using the most recent real production dataset (Alibaba Cluster Trace). The experiment's results demonstrated the efficiency of the model that identifies anomalies compared to a standard model.

Paper ID 190

Development and design of an intelligent energy router

Authors: Rachid ZIRMI (Université Mouloud Mammeri Tizi Ouzou); belkacem zouak (Université Mouloud Mammeri Tizi Ouzou)*; Nadhir Djeffal (Université Mouloud Mammeri Tizi Ouzou); Abderrahmane Alem (Mouloud Mammeri University of Tizi-Ouzou); Massinissa Kloul (Mouloud Mammeri University of Tizi-Ouzou); Hakim Achour (Mouloud Mammeri University of Tizi-Ouzou)

Abstract

An energy router is a device that regulates, dis-tributes and optimizes the power flows from renewable energywithin a domestic or industrial system. It acts as a central manager, overseeing the balance between renewable energy production, user's consumption and surplus management. In this paper, we propose the design and implementation of an intelligent energy router that dynamically optimizes energy allocation across three key pathways: Immediate consumption, storage or redis-tribution in the grid. The proposed system will manage available energy according to priorities

Paper ID 191

Ultraviolet Aging Effects on the Dielectric Properties of PVC/Al_2O_3 Nanocomposites Cables Insulation

Authors: Sabrina AMRAOUI (Université Mouloud Mammeri de Tizi Ouzou)*

Abstract

Polyvinyl chloride (PVC) is extensively employed as an electrical insulating material in high-voltage cable applications, offering reliable dielectric performance and mechanical durability. due to its excellent mechanical and electrical properties. However, under operational conditions, it is exposed to aging factors, particularly UV-radiation, which is one of the most aggressive stressors affecting its stability. The degradation induced by UV exposure leads to structural modifications, loss of mechanical properties, and alterations in dielectric performance. To enhance PVC durability, nanoparticles are commonly incorporated into the polymer matrix to mitigate aging effects. This study investigates the effects of UV aging on the dielectric properties of PVC/Al_2O_3 nanocomposites. Samples were prepared with varying aluminum oxide (Al_2O_3) concentrations (0, 2.5 and 5.0 wt.%) and subjected to accelerated UV aging tests. The study involved evaluating dielectric permittivity (ε'), dielectric loss factor (tanδ), and dielectric loss index (ε") as a functions of frequency and exposure time. Obtained results shows that adding Al_2O_3 contributes to the improvement of the dielectric performance of PVC while also acting as a protective agent against UV radiation.

Paper ID 194

Optimizing batteries charging time inside an autonomous photovoltaic system installed on a house's roof

Authors: Salah TAMALOUZT (University of Bejaia)*; Kamel DJERMOUNI (University of Bejaia); Ali BERBOUCHA (University of Bejaia); Kaci GHEDAMSI (University of Bejaia); Djamal AOUZELLAG (University of Bejaia)

Abstract

Autonomous renewable energy sources suffer from a major problem: their intermittency. For this reason, the advancement and development of storage systems plays a very important role in promoting these sources. In this sense, a renewable source must be equipped with a reliable storage system, which can overcome all the constraints related to both the source itself, the load and the installation environment. The purpose of this article is to study and analyze the

performance of a new battery charging method through some photovoltaic generators (installed on the roof of a house) we'll call battery charging at staircase voltage and compared with Constant Current and Constant Voltage (CC/CV) Charging Method, commonly used. Both tests are performed in the first one considers that the PV source is constant and the second one takes an average day southern Algeria. The optimization of the maximum power point is made using a stochastic method called "Particle Swarm Optimization (PSO)".