ICPEA
IEEE INTERNATIONAL CONFERENCE IN POWER ENGINEERING APPLICATIONS

PROGRAMME BOOK

2023 IEEE 3rd International Conference in Power Engineering Applications (ICPEA2023)

"Shaping Sustainability Through Power Engineering Innovation"

6 - 7th March 2023
Putrajaya, Malaysia

ORGANIZER:

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Contents

Foreword

On behalf of the Organizing Committee, we would like to welcome all participants to the 2023 IEEE 3rd International Conference in Power Engineering Applications (ICPEA 2023) held from 6th to 7th March 2023 via a hybrid mode (both face-to-face and virtual) at The Everly Hotel, Putrajaya, Malaysia. This conference is organized by the College of Engineering, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia and co-sponsored by the IEEE Power and Energy Society (PES), Malaysia Chapter.

ICPEA 2023 aims to foster interactive exchanges and collaborations among attendees through technical paper presentations. The conference features two distinguished keynote speakers, Professor Dr. Hussain Shareef from United Arab Emirates University and Mr. Sansubari Che Mud from Tenaga Nasional Berhad (TNB), Malaysia. They will present their speech that focus on the latest trends and challenges in the field of Electrical Power Engineering from their perspectives, and their expertise is highly appreciated by the conference organizers.

This conference will not be a successful conference without the submission of technical papers from researchers who have invested their time and energy, in writing on a variety of topics. Thus, we would like to thank all authors for supporting ICPEA 2023 and wish you a fruitful discussion throughout the event. The technical programme committee members and external reviewers also deserved appreciation for reviewing all submissions while maintaining the high standard of quality for this conference.

ICPEA 2023 would not be possible without the dedicated work and efforts of the organizing committee who worked tirelessly in every aspect. We wish to express our gratitude for your hard work and commitment to making ICPEA 2023 a success. Finally, we would like to wish everyone to stay safe and hope we could meet again in future conference.

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Zuhaila Mat Yasin
Zulkiffli Abdul Hamid

Keynote Speakers

Keynote Title:

Planning of Fast Charging Stations (CS) for Electric Vehicles (EV) with Multi Level Charging Strategy

Prof. Dr. Hussain Shareef
Department of Electrical and Communication Engineering, United Arab Emirates University

Biodata:

Dr. Hussain Shareef is currently a professor at the Department of Electrical and Communication Engineering, United Arab Emirates University, and the head of the Green Mobility Research Team at the Emirates Center for Mobil ity Research.

His research domains are related to power system planning, the integration of renewable power sources, the application of Artificial Intelligence (AI) techniques in power systems, energy management, power quality and electric vehicle grid integration. Dr. Hussain Shareef appeared as the world's top 2% scientist at Stanford University from 2020 to 2022. Among his many awards, Dr. Hussain Shareef is a 2019-2020 recipient of the United Arab Emirates University Award for Excellence in Scholarship and Chancellor Innovation Award 2020-2021. He received his PhD degree from Universiti Teknologi Malaysia (UTM) in 2007 and he has published more than 400 peer-reviewed journal papers in various fields related to power and energy systems. He has more than 5500 citations with an h-index of 37.

Dr. Hussain Shareef is a member of the Mohammed Bin Rashid Academy of Scientists and the Institute of Electrical and Electronic Engineers (IEEE).

Keynote Speakers

Keynote Title:

Sustainability and Power Utility of The Future

Mr. Sansubari Che Mud
Head (Customer & Market) for Distribution Network, Tenaga Nasional Berhad (TNB), Malaysia

Biodata:

Mr. Sansubari Che Mud is the Head (Customer & Market) for Distribution Network, Tenaga Nasional Berhad (TNB). Prior to that, he was Chief Engineer (Asset Strategy & Policy) and General Manager for Sustainable Energy Development for TNB. A strong advocate for sustainable energy development, renewable energy, and energy efficiency. His professional interest focus on sustainable energy development in Malaysia and his current project include Smart Utility 2025 and Smart Energy Management Infrastructure.

Mr. Sansubari earned his Bachelor Degree from University of Warwick, England in Electrical Power and Master's Degree in Power System from University of Malaya and Master of Business Administration (MBA) from Universiti Tenaga Nasional (UNITEN)/Melbourne Business School. He was two times Association of Southeast Asian Nations (ASEAN) Energy Manager's Award recipient for his effort on energy efficiency in Malaysia. His involvement in sustainable energy development started as one of the pioneer team members under Malaysia Special Committee on Renewable Energy (SCORE) which was promoting for renewable energy development and introduced the first commercial grid connected renewable energy power plant project in Malaysia.

Agenda

Time (*UTC +08:00, Kuala Lumpur, Singapore*)	**Day 1: 6/3/2023 (Monday)**	**Day 2: 7/3/2023 (Tuesday)**
8:00 - 9:00 am	Registration & Light Refreshment	Registration & Light Refreshment
9:00 - 9:45 am	Opening Ceremony	Forum: "Smart City: Malaysia Experience" by Panel 1: Dr. Lim Seng Boon (UiTM Perak) & Panel 2: Mr. Mohd Khairun Nizam Mohd Sarmin (TNBR)
9:45 - 10:15 am	Keynote Speaker 1: Planning of Fast Charging Stations (CS) for Electric Vehicles (EV) with Multi Level Charging Strategy by Prof. Dr. Hussain Shareef	
10:15 - 10:30 am		Coffee break 1
10:30 - 11:00 am		Session 2_1 (virtual): Power System Operation and Planning/ Smart Grid/Energy and Environment in Power Engineering Application Session 2_2 (f2f): Renewable Energy and Storage/ Internet of Thing (IOT) in Power Engineering Application/ Energy and Environment in Power Engineering Application Session 2_3 (f2f): High Voltage Engineering & Technology/ Data Analytics in Power Engineering Application
11:00 - 11:15 am	Photo Session	
11:15 - 11:30 am	Coffee Break 1	
11:30am - 12:30pm	Keynote Speaker 2: Sustainability and Power Utility of The Future by Mr. Sansubari Che Mud	
12:30 - 12:45 pm		Lunch break
12:45 - 2:15 pm	Lunch break	
2:15 - 2:30 pm		Session 2_4 (virtual): Renewable Energy and Storage Session 2_5 (f2f): Power System Operation and Planning Session 2_6 (f2f): Energy and Environment in Power Engineering Application/Power System Operation and Planning
2:30 - 3:30 pm	Session 1_1 (virtual): High Voltage Engineering & Technology / Power System Economics and Electricity Markets / Energy and Environment in Power Engineering Application Session 1_2 (f2f): Power System Operation and Planning Session 1_3 (f2f): Power Electronics and Applications	
3:30 - 3:45 pm	Coffee break 2	Coffee Break 2
3:45 - 5:15 pm	Session 1_4 (virtual): Smart Grid/ Renewable Energy and Storage Session 1_5 (f2f): High Voltage Engineering & Technology Session 1_6 (f2f): Power System Operation and Planning/Energy and Environment in Power Engineering Application	Session 2_7 (virtual): Power Electronics and Applications / Energy and Environment in Power Engineering Application Session 2_8 (f2f): Electric and Hybrid Vehicles/ Power Electronics and Applications Session 2_9 (f2f): Renewable Energy and Storage

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Monday, March 6

Monday, March 6 8:00 - 9:00

Registration & Light Refreshment

Monday, March 6 9:00 - 9:45

Opening Ceremony

Room: Irama 5

Monday, March 6 9:45 - 11:00

Keynote Speaker 1: Planning of Fast Charging Stations (CS) for Electric Vehicles (EV) with Multi Level Charging Strategy by Prof. Dr. Hussain Shareef

Virtual
Room: Irama 5
Chair: Hazlie Mokhlis (University of Malaya, Malaysia)

With the growing concerns on energy depletion and carbon emissions, electric vehicles (EVs) have marked a new paradigm in the transport sector. Installation of publicly accessible charging infrastructure, namely fast charging stations (CS) is crucial for the large-scale deployment of EVs. However random positioning of charging stations may create traffic congestion, charging dissatisfaction for EV owners and inefficient charging station operation. Moreover, it affects the performance of electrical distribution networks in terms of grid overloading, increase in power loss and voltage instability due to the simultaneous charging of EVs. These impacts on the electric grid are more significant in the case of fast-charging strategies. This talk presents a coordinated fast CS planning model that considers the efficiency of CS, the impact on the power grid and the benefits of EV users. A multi-level charging station concept that supports different charging power levels in the future reduces the charging waiting time and improves the station's efficiency. This planning model will be beneficial for sustaining the fast-growing demand for EVs in United Arab Emirates (UAE) and helps to prepare a plan to locate and size the CSs that benefit all stakeholders.

Monday, March 6 11:00 - 11:15

Photo Session

Room: Irama 5

Monday, March 6 11:15 - 11:30

Coffee Break 1

Monday, March 6 11:30 - 12:45

Keynote Speaker 2: Sustainability and Power Utility of The Future by Mr. Sansubari Che Mud

Physical
Room: Irama 5
Chair: Nur Ashida Salim (Universiti Teknologi MARA, Malaysia)

The energy landscape is changing rapidly with far-reaching implications not just for global energy industries but also local power industries. Main challenges facing power utility in the world and domestic are how they manage and fit-in into energy transition. Energy transition refers to the change of the energy system from fossil fuel-based sources to renewable energy sources. For that matter, power utilities have been working to advance the idea of smart utility or utility of the future, which are beyond tra ditional eco-system into more flexible and robust network. Tenaga Nasional Berhad (TNB) is embarking on modernizing the national grid into the grid of the future, smart networks which are resilient and flexible yet reliable in meeting the country's need for energy tra nsition. The keynote also present TNB's energy transition journey while balancing power industry trilemma and facilitate new energy landscape via smart utility project.

Monday, March 6 12:45 - 2:30

Lunch break

Monday, March 6 2:30 - 3:30

Session 1_1 (virtual): High Voltage Engineering & Technology / Power System Economics and Electricity Markets / Energy and Environment in Power Engineering Application

Room: Irama 5
Chair: Zulkiffli Abdul Hamid (Universiti Teknologi Mara, Malaysia)

2:30 *Short-Circuit Fault Detection in Power Transformer Using Frequency Response Analysis Bipolar Signature of Inductive Inter-Winding Measurement*

Ahmed Allawy Alawady (Universiti Tun Hussein Onn Malaysia & The Islamic University, Najaf, Malaysia); Salem Mgammal Al-Ameri (Curtin University Malaysia, Malaysia & Curtin, Malaysia); Zulkurnain Abdul-Malek (Universiti Teknologi Malaysia & Institute of High Voltage and High Current, Malaysia); Mohd Fairouz Mohd Yousof (Universiti Tun Hussein Onn Malaysia, Malaysia); Ali Ahmed Ali Salem (University Tun Hussien Onn Malaysia - uthm, Malaysia)

The short circuit fault detection practices of power-transformer winding is important to ensure its unfailing and proper operation. In this regard, Frequency response analysis (FRA) is a favorable tool that can be used to detect such fault. The FRA method has four measurement configurations called: open circuit, short circuit, inductive inter-winding, and capacitive inter-winding. However, a method of detecting the short circuit fault using FRA open circuit and short circuit measurement is investigated. This paper aims on investigating the inductive inter-winding of short circuit faults by showing a bipolar signature. The FRA inductive inter-winding measurement has been obtained from 11/0.415 kV, 500kVA distribution transformer to interpret the characteristics of resonances indicating a bipolar signature. There is a different level of short circuit fault artificially applied to the transformer winding. The inductive inter-winding measurements show that the resonances showing the bipolar signature at the mid-frequency range can be employed to determine the short circuit fault in the transformer winding. Based on this finding, a process of identifying the short circuit fault of a transformer winding is proposed. The data of short circuit fault and normal data of FRA measurement are compared. The proposed method can add to improving the application of using the FRA method to detect faults in power transformers.

2:45 *Power Transformer Insulation System Health Index with Missing Data Prediction Using Random Forest*

Geby Chintia (Bandung Institute of Technology, Indonesia); Rahman Azis Prasojo (Politeknik Negeri Malang, Indonesia); Suwarno Suwarno (Institut Teknologi Bandung, Indonesia)

Health Index approach is currently one of the most common ways to assess the overall condition of power transformers. Data unavailability is still a problem in Health Index assessment. This paper discusses the prediction of transformer health conditions using five missing data replacement methods, which are removed parameter, average value, assume good, SLR, and Random Forest prediction. Seven scenarios based were simulated based on three missing parameters, namely 2FAL, IFT and Water Content. The accuracy is evaluated using the Health Index calculated with complete parameter. As much as 504 units of 150 kV power transformers were used in the analysis. The results show that Random Forest method produced the highest accuracy rate among the other methods with average value of 92%. Keywords - Health Index, Power Transformer, Condition Monitoring and Diagnostics, Random Forest, Missing Value.

3:00 *Risk Management of Stochastic Power Generation Outages by Load Curtailment Program*

Khalid Alqunun (University of Hail, Saudi Arabia)

The challenges of random generation outages are one of the major concerns in modern power systems. The unexpected power generation outages lead to a severe damage in one or more of the power components. This damage requires immediate scheduling of the available generation units to minimize the risks and increase the system security. This paper presents an optimization technique of load curtailment to be immediately applied in case of power generation outages. The optimization method involves a prompt response of the generation outages through predefined variables and constraints. The objective function of the proposed technique takes into account the power dispatch cost and the compensation cost, which will be paid directly to the end-user customers as a reward for their contribution of curtailing some of their loads. The amount of the power dispatch and the load curtailment are precisely evaluated using Mixed-Integer Linear Programming, where all the possible variables are tested before reaching a feasible solution. Example studies are presented to explore the performance of the load curtailment and to schedule all the energy sources during stochastic scenarios of the generation outages.

3:15 *Towards a Sustainable Mosque Building- Assessment Study Based on Dubai Climate*

Hanan Taleb (British University in Dubai, United Arab Emirates); Issah M. Alhamad, Shamma Alaryani and Rashed Khader (United Arab Emirates University, United Arab Emirates)

Mosque buildings consume large amounts of energy due to their generally large sizes and number of worshippers. Hence, it is critical to adopt the appropriate energy-saving approaches to lower the energy consumption in such buildings. This work is an assessment simulation study for six energy-saving strategies for mosque building design. These strategies include: building air tightness and infiltration, solar water heaters, wall construction and insulation, windows glazing, windows shading, and scheduled air conditioning operation. The buildings' energy modeling was done using Carrier Hourly Analysis Program (HAP). The results show that maximum power savings were achieved by the scheduled air-conditioning operation strategy, which was able to reduce the building's annual load consumption by 19.4%, followed by the air tightness strategy which was able to reduce the total building's annual load by 5.8 %. The windows shading and windows glazing strategies were able to reduce the total annual building load by 2.6 % and 0.7 % respectively. The wall insulation strategy enhanced the power saving by 1.45% and the solar heater strategy was able to achieve a power consumption reduction of 1.25%. The total annual power consumption due to all six strategies was found to be almost 30% of the baseline model.

Session 1_2 (f2f): Power System Operation and Planning

Room: Irama 6
Chair: Norziana Aminudin (Universiti Teknologi MARA, Malaysia)

2:30 *Islanding Scheme Design for Generators and Assessment of Impact of RGMO on Frequency Stability of Island*
Saibal Ghosh (Power System Operation Corporation Limited & ERLDC, India); Pritam Mukherjee (Grid Controller Of India Limited, India)
Transmission system forms the backbone of any electrical power system. Transmission systems are exposed to environment and prone to fault. Therefore, chances of unwanted event resulting in large scale blackouts can never be ruled out. Renewable integration has increased the vulnerability of power system. Therefore, over the year resilience is gaining more and more importance for power system planners. Many grid codes have implicit provision of resilience. Key features of a resilient power system are robust islanding scheme and adequate number of black start resources. When a large power system fails to operate in synchronism that time creating small island is always preferable as the surviving island makes the restoration process fast. Success of an islanding scheme depends on the design as well as implementation of the logic. Logic needs to be robust as well as simple. Extensive study is required to design an effective islanding scheme. For islanding scheme design various preliminary studies are done and the results are discussed in the paper. The purpose of the studies was solely to check the frequency stability of the island. These islanding logic needs to be designed purely based on frequency logic and no under voltage logic to be used. This is because these islands are designed for supply of capital city, only in case of total or partial grid failure. Therefore, here island scheme design only aims at arriving frequency setting and load shedding scheme design inside the island. However, these studies are done based on certain assumption which will also be discussed in the paper. Its purpose is to check the broader feasibility of an islanding scheme. The final islanding logic may be finalized by the respective generating plants in consultation with their OEMs. The governor of a generating unit has a vital role to play in the success of the islanding. Currently in Indian power system restricted governor mode of operation (RGMO) is in service for generators [1]. In this paper the impact of RGMO on island frequency stability is also studied.

2:45 *Implementation of Certainty Level (CL) to Condition Assessment Factor (CAF) Index on High-Voltage Circuit-Breaker (HVCB) on Sulmapana Region*
Eko Yulianto (PT PLN, Indonesia); Rahman Azis Prasojo (Politeknik Negeri Malang, Indonesia)
Condition assessment factor (CAF) index for the high voltage circuit breaker (HVCB) developed by the PT PLN Transmission Division of Sulawesi, Maluku, Papua and Nusa Tenggara is an HVCB condition assessment method based on its periodic maintenance data. CAF HVCB uses 6 parameters, which are Contact Resistance, CB Timing, Insulation Resistance, Insulation Quality Test, Anomaly and CB Accessories. Each parameter produce score level and aggregate with different weighting factor to generate CAF index. According on actual conditions, one of the obstacles to generate CAF value is the incomplete of periodic maintenance data. Therefore, Certainty Level (CL) needed to be included as information with CAF index to overcome the problem of incomplete data. CAF index is implemented for 185 HVCB based on periodic maintenance data in 2021. The results of the CAF value show that most of the HVCB are in good condition with a high CAF index and CL. Based on the result, immediate activities need to be carried out to ensure the condition of HVCB before breakdown, especially HVCB with CAF value less than 3 needs to be priorities due its "poor" assessment result.

3:00 *Prioritizing Load Break Switch Placement: Application of Fuzzy AHP-TOPSIS Approaches*
Nathan Saputra Sitohang (Jalan K. L. Yos Sudarso, Indonesia & PT PLN (Persero), Indonesia); Mohammad Isa Irawan (Institut Teknologi Sepuluh Nopember, Indonesia); Hadi Sutanto Saragi (Del Institute of Technology, Indonesia); Rikardo Simanjuntak (PT PLN (Persero) & USU, Indonesia); Akmaluddin Saragih (Universitas Sumatera Utara, Indonesia)
PLN UP2D Sumut, the state-owned electricity company in North Sumatra Province, Indonesia, has a role in operating the 20 kV electricity network system in North Sumatra Province. Installing the load break switch (LBS) in the network system is one way to ensure the reliability of that operation. In this study, seven LBSs will be installed in four different work zones for 30 nominated feeders. That should meet six criteria determined by an expert, e.g., Energy Not Served (ENS), SAIDI, SAIFI, length, network availability, and load of each feeder. The fuzzy analytic hierarchy process (FAHP) and technique for

ordering preference by similarity to an ideal solution (TOPSIS) are both used in this work. Before determining the rank of the selected feeder using TOPSIS, the weight of each criterion must first be determined using FAHP. Based on the fuzzy AHP results, ENS is found to be the most impactful criterion. Furthermore, based on the TOPSIS results, the services area of Medan and Lubuk Pakam have the highest number of feeders selected for prioritizing LBS placement.

3:15 *Comparative Study of Power System Security Assessment Using Deterministic and Probabilistic Methods*
Norziana Aminudin (Universiti Teknologi MARA, Malaysia); Siti Rafidah Abdul Rahim (Universiti Malaysia Perlis, Malaysia); I Musirin (Universiti Teknologi MARA, Malaysia); Rahmatul Hidayah Salimin (Universiti Teknologi MARA Shah Alam, Selangor, Malaysia); Mohd Abdul Talib Mat Yusoh (Universiti Teknologi MARA (UiTM), Malaysia); Yusrina Yusof (Universiti Teknologi MARA, Malaysia)
Escalating electricity demand has forced the power system to operate very close to its security margin. Any unpredicta ble occurrence of a contingency would exacerbate the condition and threaten power system security. Thus, it is of utmost importance for the system operator to evaluate the actual system health accurately to avoid voltage collapse incidents and to evade overly conservative protection. This paper presents a risk-based security assessment (RBSA) in power system operation that quantifies the degree of risk faced by the system in its proximity to voltage stability violations due to transmission line outages that occur in the system. The risk value is calculated by considering the closeness of the system condition to the point of instability, which is also regarded as severity, as well as the likelihood of the contingency to occur. In the research, the performance of RBSA is compared with the traditional deterministic method in assessing power system conditions. The IEEE 30 bus system is engaged as the test system, and the simulation is done using MATLAB software.

Session 1_3 (f2f): Power Electronics and Applications

Room: Irama 7
Chair: Nor Farahaida Abdul Rahman (Universiti Teknologi MARA, Malaysia)

2:30 *Thermal Characterization of Power Gallium Nitride Transistor*
JungKyun Kim (Siemens, Korea (South))
This paper shows that thermal characterization of power GaN transistor using the thermal transient measurement method, package modeling, simulation, and calibration optimization with HEEDS. The thermal model calibration tasks using transient thermal measurement for even more accurate thermal simulations and improve the reliability of components. The ability to find a measurable structure allows us to create a simulation model of the package and calibrate it against the measured thermal signal. We also demonstrated the thermal model calibration using SHERPA (Systematic Hybrid Exploration that is Robust, Progressive and Adaptive) algorithm within the HEEDS software. Calibrated structure function of power GaN module had matched with measured structure function with accuracy 99.77% and calibration extent 5.0 K/W.

2:45 *Scaling-Free Transformations for Stability-Guaranteed Variable Notch-Frequency Filters*
Tian-Bo Deng (Toho University, Japan)
Digital notch filters can be employed in removing a single or multiple unwanted frequency components in digital signals. For example, the signal components to be removed include the interference signals from power lines. Such unwanted frequencies are called notch frequencies, and notch filters play the central role in removing the unwanted signal components. Ideally, the magnitude responses of a notch filter at notch frequencies should be zero. To implement a notch filter with a recursive structure, it is mandatory to guarantee its stability. Otherwise, the notch filter becomes useless. a useful technique is presented in this paper for guaranteeing the stability of a recursive variable notch-frequency (NF) filter. By employing this stability-guarantee technique, a notch filter can be designed with a recursive structure, and its stability is absolutely ensured. This stability-guarantee technique is derived from the well-known stability-triangle condition, and it utilizes parameter transformations. After showing the stability-guarantee technique, we apply it to the design of a digital notch filter whose notch frequency is variable. This illustrative example not only verifies the guaranteed stability, but also demonstrates the high design accuracy.

3:00 ***Line-Interactive Transformerless Bidirectional Buck-Boost Uninterruptable Power Supply System with Battery Control Algorithm***

Nor Farahaida Abdul Rahman and Nurhafiza Sukmin (Universiti Teknologi MARA, Malaysia)

A transformerless bidirectional buck-boost line-interactive uninterruptable power supply (UPS) system with a battery control algorithm has been proposed. The suggested UPS can protect loads from interruption. It is equipped with a full-bridge inverter and a bandless hysteresis control method. It functions as a rectifier during normal supply and as an inverter during interruptions. A bidirectional buck-boost converter replaces the transformer and serves as a charging and discharging circuit for battery management. MATLAB/Simulink replicates the UPS to determine its performance during the outage. Based on the simulation findings, both independent control algorithms can govern the functioning of both converters in both modes of operation. As a consequence, the UPS system may provide sinusoidal waveforms with low Total Harmonic Distortion (THD) output.

3:15 ***Energy Efficiency Using Dynamic Voltage Restorer (DVR) Integrated Photovoltaic and Energy Storage Systems***

Mohamad Soleheen Mohd Tamam, Muhammad Murtadha Othman and Kamrul Hasan (Universiti Teknologi MARA, Malaysia); Masoud Ahmadipour (University Teknologi MARA & Universiti Teknologi MARA (UiTM) Malaysia, Malaysia)

Major power quality disturbances such as voltage sag, voltage swell and harmonic usually occurred in electrical power systems mainly in the distribution part that may affect the performance of the circuit and it can be mitigated by installing the Dynamic Voltage Restorer (DVR). Based on the novel integration of DVR, a solar PV-Battery and a supercapacitor (SCAP) are implemented in this circuit which is used to inject the required voltage in sustaining the mitigation of power quality disturbance, especially voltage sag and voltage swell. Solar PV-Battery and SCAP are implemented to meet the necessary power required by the grid and also for power quality improvement. In addition to the voltage regulation, the proposed solar PV-Battery reduces the energy consumption from the utility grid by disconnecting the utility grid from the load. The supercapacitor has a low energy density and a high power density that is ideal for the compensation of voltage sags and swells that require high power for short spans of time. It also will independently compensate for temporary voltage sags and swells without interrupting the grid to compensate for the power quality. The simulation results are presented using MATLAB/Simulink to show the effectiveness of the proposed system and its controlling system on power quality disturbances.

Monday, March 6 3:30 - 3:45

Coffee break 2

Monday, March 6 3:45 - 5:15

Session 1_4 (virtual): Smart Grid/ Renewable Energy and Storage

Room: Irama 5

Chair: Siti Zaliha Mohammad Noor (Universiti Teknologi MARA, Malaysia)

3:45 ***A Robust State Estimation Method for Unsymmetrical Three-Phase Power Systems***

Hussaini Ali Adamu (University of Birmingham & Kaduna Electric, United Kingdom (Great Britain)); Xiao-Ping Zhang (University of Birmingham, United Kingdom (Great Britain))

In the current literature, it is well established in most cases, that the same weights or weight factors (reciprocal squares of the variances) are used in the conventional weighted least squares (WLS) power system state estimation algorithm. However, this has caused some significant deviation in the solution when compared to the true or actual solutions, due to significant errors. Furthermore, several research studies from the literature had often analyzed the state estimation procedure in single-phase. Nevertheless, this paper proposes a new 3-phase re-weighted nonlinear regression method, that uses the Welsch weight function as the updating weight factor incorporated into the weighted least squares normal equation formulation, to minimize the significant deviations caused by the measurement errors. The proposed method is in 3-phase and is investigated on a 13-node IEEE test feeder in MATLAB, with 0.01% error added to the measurements,

and compared using the same conditions with the 3-phase conventional state estimation (CSE) and a 3-phase load flow actual standard solution. First, it is shown that the proposed method outperforms the 3-phase conventional state estimation method in terms of feasibility when the error feasibility performance index is computed. Finally, the differences in term of estimation accuracy, for the proposed method is highlighted using two performance accuracy indexes (Voltage and Angle) for validation and are shown on the bar chart.

4:00 ***A Novel Active Cooling Technique for Photovoltaic in Harsh Area***

Mohammed S Raja, MSR and Ahmed J. Abid (Middle Technical University, Iraq); Zuhair Sameen Shuker (Middle Technical University & Baquba Technical Institute, Iraq)

The performance of photovoltaic panels decreases significantly when the temperature of photovoltaic panels is raised. In harsh environments such as Iraq, which has a scorching climate in the summer, the photovoltaic systems are suffering from high mitigation in power production despite the high sunlight intensity. In this experimental study, a cooling system was designed, implemented, and tested on a photovoltaic panel. A closed-loop water stream cooling system was proposed to collect heat from the back of the photovoltaic panel, then dissipate it via a heat radiator. An Arduino-based device was designed especially for this experiment for collecting the panel data including panel temperature in different spots, water temperature, ambient temperature, and panels' voltage & current. The results were compared with a twin panel that was not cooled and under the same circumstances. Results showed that the proposed cooling system increases the productivity of the photovoltaic panel by 72%. In addition to that results show that the even distribution of the heat for the photovoltaic panel due to using the proposed cooling system contributes to reducing the effect of the hot spot.

4:15 ***A Systematic Review for Enhancing Solar Photovoltaic System Efficiency by Reducing the Panel Temperature***

Mohammed S Raja, MSR and Ahmed J. Abid (Middle Technical University, Iraq); Zuhair Sameen Shuker (Middle Technical University & Baquba Technical Institute, Iraq)

Renewable energies are of extraordinary significance for energy producers in growing countries. Wind energy, hydropower, geothermal energy, bioenergy, and solar energy is a more sensible alternative than other resources, the answer to the high energy demand. However, Solar energy is considered promising, fast-developed, and cost-efficient compared to other renewable energy sources. Unfortunately, PV Solar efficiency is highly dependent on temperature, and reducing this dependence or its effect on energy production is mandatory. In this article, 44 articles are systematically reviewed and then classified according to their cooling methods, mainly into active and passive methods. In the active methods, the forced air and water as coolants were considered, while the natural air and the heat pipe were adopted in the passive methods. Results show a comparison between the presented methods in the durability, maintenance required, efficiency, operation noise, lifespan, capital cost, and consumed energy.

4:30 ***Four Bioinspired Optimization Techniques in PV MPPT Under Uniform and Non-Uniform Shading***

Hasan S Ahmed, Ahmed J. Abid and Adel Obed (Middle Technical University, Iraq)

Photovoltaic (PV) is one of the renewable sources that increased application because have no mechanical part. The surrounding conditions (irradiance, temperature) affect the output power from PV. Moreover, partial shading between panels affects the P-V curve which reduces the output power generated from PV. Several maximum power point tracking algorithms are utilized for each maximum of power from PV. This study compares the conventional P&O approach with four meta-heuristic algorithms PSO, GWO, CS, and HHO in terms of maximum power, efficiency, rising time, and settling time under uniform and non-uniform irradiation. Techniques are simulated in MATLAB/SIMULINK. It is observed that the results were obtained in three cases: in case1) uniform irradiation in three patterns (high, medium, and low), the PSO is the high efficiency in high irradiation but high efficiency in medium irradiation is GWO and in low irradiation the high efficiency is CS. In case 2) non-uniform irradiation with a step change in irradiance for every second with constant temperature, the PSO is high efficiency. In case 3) with a change in irradiance and temperature every second the HHO has the highest efficiency.

4:45 *Green Hydrogen Scale Prediction Based on System Dynamics Model for Carbon Neutrality*

Hualin Yang and Changhong Zhao (North China Electric Power University, China); Zhicheng Li (State Grid Fujian Electric Power Company, China); Tingting Lu (China National Intellectual Property Administration, China)

Carbon neutralization has become a topic of common concern in the world. China plays an important role in the global carbon neutrality process. Hydrogen energy is considered to be an important choice under carbon neutralization. The future scale and the development pattern of hydrogen energy will directly affect China's energy transition. Policy formulation related to hydrogen energy will influence the evolution of the hydrogen energy industry. This paper establishes a system dynamics model for the green hydrogen production industry in China supported by government subsidy policies. In the model, the range and trend of policy subsidy proportion and tax proportion are set differently. The results show that when the green hydrogen production industry has an income tax of 25% and no installation subsidies, the low, medium and high demand scenarios for end-use green hydrogen cannot be met. Appropriate policy combinations are needed to meet the demands of green hydrogen in different scenarios. A subsidy rate from 30% to 10% with a fall of 10% every four years and an income tax rate from 15% to 25% with an increase of 5% every four years are selected as policy combinations in the low-demand scenario. A subsidy rate from 30% to 10% with a fall of 10% every four years and an income tax rate of 25% is selected as policy combinations in the middle and high-demand scenarios. Finding an appropriate and reasonable policy combination is the right choice to support the development of the green hydrogen production industry to meet the demand for green hydrogen. This study will provide a reference for the prediction of the green hydrogen industry scale, as well as an investment reference for other green hydrogen practitioners and managers.

Session 1_5 (f2f): High Voltage Engineering & Technology

Room: Irama 6

Chair: Azrul Mohd Ariffin (Universiti Tenaga Nasional, Malaysia)

3:45 *Simulation Analysis for 33 kV Porcelain Insulator String Based on Room Temperature Vulcanize Coating*

Mardianaliza Othman (Universiti Malaysia Perlis, Malaysia)

Porcelain insulator is widely used in high voltage transmission lines due to its high mechanical strength, performing well on heat and aging resistance. However, porcelain insulator string is always exposed to environmental contamination. The presence of accumulation contamination on the porcelain insulator string surface reduces the electrical performance and causes insulation failure in transmission and distribution lines. Literature has shown that the conventional method to prevent contamination is limited to periodically water washing and silicone grease, involving some limitations in practice from the technical and economic point of view. Therefore, this research investigates the performance of porcelain insulator string due to the contamination effect based on Room Temperature Vulcanize (RTV) coating in 33 kV transmission line system. The four-unit porcelain insulator string in 2-D form was first developed using computer-aided design (CAD). Electric field and voltage distribution results were analysed using finite element method (FEM) software. After adding RTV coating, the percentage decrement of electric field distribution value is 9.73% from the study. This has proven that the porcelain insulator string with a significantly lower electric field distribution may protect the transmission lines from a higher risk of corona or even flashover.

4:00 *Investigation of Acetylene Gas and Internal Hotspot in the Low Voltage Bushing of Power Transformer #1 Telukjambe Substation*

Andika Bagaskara, Luthfi Yahya and Rahmad Dwi Prima (PT. PLN (Persero), Indonesia)

The power transformer is one of the most important equipment in the electric power system. In the electricity system at PLN, premium customers are a priority to maintain reliability. Telukjambe substation is a radial subsystem, so Periodic testing of power transformers is very important to maintain power reliability. On the online measurement results, the results of dissolved gas analysis were found and there was a hotspot on the secondary bushing. Several methods were used to determine the occurrence of damage to the power transformer equipment, such as Sweep Frequency Response Analysis (SFRA) and Tan Delta., the parameters of concern are the Sweep Frequency Response Analysis (SFRA) test and the winding resistance test. the SFRA test found obvious distortion at low frequency and winding resistance deviation was found to reach 12%. when overhauled, carbonized symptom was found on the rod bushings connected to the lead

windings. Dissolved gas on the transformer suspects from setting on motor drive couple to OLTC resulting in selector switch connection not perfect. It showed by mark in connection selector switch where overhaul carried out.

4:15 ***UV-Vis Spectra and Moisture Content of Retrofilled Aged Mineral Oil with Synthetic Ester***

Nur Amirah Othman, Hidayat Zainuddin and Muhammad Sharil Yahaya (Universiti Teknikal Malaysia Melaka, Malaysia); Norhafiz Azis (Universiti Putra Malaysia & Centre for Electromagnetic and Lightning Protection Research, UPM, Malaysia); Zulkifli Ibrahim (Universiti Teknikal Malaysia Melaka, Malaysia); Mohd Affendi Che Musni (Power Transcoteq and Services Sdn Bhd, Malaysia)

Retrofilling aged mineral oil (AMO) with ester oils is now being explored as an alternative option for the extension of transformer life. In transformer retrofilling, there is up to 10 % of aged mineral oil will be mixed with new oil. It is anticipated that the dielectric properties of the ester oil will be affected when the oils are mixed together. In this paper, synthetic ester (SE) oil was investigated in terms of its physicochemical properties after being mixed with various proportions of aged mineral oil. An accelerated thermal aging of mineral oil has been firstly prepared prior to the retrofilling with SE oil. The mineral oil was aged in a vacuum oven at 130 °C for 150 hours. There are three different proportions, i.e. 3 %, 5 % and 7 % were selected for use in the retrofilling process. Further, the retrofilled aged mineral-synthetic ester (AMO/SE) oil was tested for the moisture content and evaluation of degradation products through Ultraviolet-Visible Spectroscopy (UV-Vis) spectra. Based on the findings, it was interestingly found that the higher proportion of AMO has reduced the moisture content of retrofilled AMO/SE. In terms of UV-Vis spectra, the higher proportion of AMO has increased the absorbance with longer wavelength and it is in line with the concentration of dissolved decay products (DDPs). Overall, the moisture content and the concentration of DDPs of retrofilled AMO/SE has still meet the requirement as a new oil.

4:30 ***Influence of Deep Trap Density and Injection Barrier Height Towards Accumulation of Space Charge Within Dielectrics***

Imran Daniel Salim (College of Engineering, Malaysia); Nik Hakimi Nik Ali (Universiti Teknologi MARA & Shah Alam, Selangor, Malaysia); Azrul Mohd Ariffin (Universiti Tenaga Nasional, Malaysia); Atip Doolgindachbaporn (King Mongkut's University of Technology Thonburi, Thailand); Tze Mei Kuan (Universiti Tenaga Nasional, Malaysia); Mohd Abdul Talib Mat Yusoh (Universiti Teknologi MARA (UiTM), Malaysia)

Over a decade, insulation technologies have undergone numerous developments to provide better protection for high-voltage direct current (HVDC) equipment. HVDC system has been regarded by the power industry as a medium for long-distance bulk transmission over high voltage alternating current (HVAC). Various types of materials have been used to insulate the HVDC equipment. However, the lack of knowledge about the nature of space charge accumulation which is one of the major problems with HVDC system performance has brought challenges to the industry. It is impractical for the industry to manufacture perfect insulation that could sustain any cause of breakdown due to poor chemical properties. The insulation age or impurities existing within the insulation morphology can influence the accumulation of space charge, thus leading to distortion of an electric field in the insulation material. The constant electric field distortion can accelerate the ageing process of the insulation material itself. To improve the insulation performance, it is important to study the influence of different deep trap densities and the injection barrier height parameters on the behaviour of space charge. This paper will focus on the investigation of space charge behaviour by using a bipolar charge transport (BCT) model on low-density polyethylene (LDPE) and cross-linked polyethylene (XLPE), which both are common polymeric insulations for HVDC cable. In this paper, the effect of different parameters of both deep trap density and injection barrier height on space charge behaviour will be studied based on the charge density and electric field. It has been observed that the deep trap density and injection barrier height affect the accumulation of space charge in the LDPE and XLPE.

Session 1_6 (f2f): Power System Operation and Planning/Energy and Environment in Power Engineering Application

Room: Irama 7
Chair: Mohd Abdul Talib Mat Yusoh (Universiti Teknologi MARA (UiTM), Malaysia)

3:45 *Classification of Faults on the Shipboard Distribution Power System*
Mohd Abdul Talib Mat Yusoh (Universiti Teknologi MARA (UiTM), Malaysia); Ahmad Farid Abidin (Faculty of Electrical Engineering, Universiti Teknologi Mara, Malaysia); Nadiah Mohd Basri (Universiti Teknologi MARA, Malaysia); Nor Zulaily Mohamad (Universiti Teknologi MARA Shah Alam, Selangor, Malaysia); Nik Hakimi Nik Ali (Universiti Teknologi MARA & Shah Alam, Selangor, Malaysia); Choong Chin Aun (TLDM Lumut, Malaysia)
This paper discusses the issue of electrical power quality and how it affects the ship safety. Since the new techniques for producing and utilizing electrical energy in the ship systems have been introduced, there is a need to consider the increase in the significance of Power Quality. The objective of this paper is to classify the PQ disturbances on the ship using Ensemble Bagged Tree, Nearest Neighbors and Support Vector Machine. Hence, the electrical model on the ship distribution system is develop based on the real measurement data. The types of PQ disturbances that has been considered in this classification scheme are voltage sag, voltage swell and combination of voltage swell and voltage transient. In order too get the high performances in the classification scheme, the S-Transform (ST) is chosen to extract the significant features used by the classifiers. In this case, 40% of total data is used for training and the remaining data will be used for testing. The results shows that the Ensemble Bagged Tree presents high accuracy rate of 91.7% compared to the Nearest Neighbors and Support Vector Machine.

4:00 *Optimizing Power Plant Development for Fakfak System Using Generation Expansion Planning*
Alfian Muhammad Reza and Anugerah Nur Arif Wicaksono (PT PLN Enjiniring, Indonesia); Aga Batry Heksaprilla (PT PLN, Indonesia); Wismanto Setyadi, Muhammad Firmansyah and Muhammad Asyari (PT PLN Enjiniring, Indonesia)
The Indonesia Power Plant development planning was drafted at Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) or Electricity Supply Business Plan 2021-2030. In actuality, several stated planning needs to be optimized regarding current conditions. A few of them suffered land acquisition issues and one of them happened in the Fakfak system. Two thermal power plants (MPP and GEPP) are planned to be constructed, targeted to COD in 2022 and 2025 respectively. Unfortunately, the land acquisition issues cause those targets can't be achieved. Using generation expansion planning simulation, those targets can be evaluated based on current conditions and the required electricity supply. Furthermore, developing a photovoltaic power plant (PVPP) becomes a variable to optimize the model. Adding PVPP can give a COD (Commercial Operation Date) target tolerance to the base power plant development (mobile power plant and gas engine power plant). Based on study conditions and assumptions, the regional cost of electricity and carbon emissions intensity will be lower in the presence of PVPP.

4:15 *An Efficient Method for Available Transfer Capability Calculation Considering Cyber-Attacks in Power Systems*
Mostafa Eidiani (Khorasan Institutr of Higher Education, Iran); Hossein Zeynal (Buein Zahra Technical University, Iran); Zuhaina Zakaria (Universiti Teknologi MARA, Malaysia)
At this work, the impact of cyberattacks in power system Available Transfer Capability (ATC) solution is investigated using DIgSILENT Power factory software. Based on the literature, there reported several power network blackouts that caused by hackers and the Stuxnet worm in Ukraine, which exhibited that power systems are quite vulnerable to widespread and integrated cyberattacks. As a result, power market clearing mechanism and ATC solution can no longer be reliable if hackers possess enough information to manipulate input data. Instead of using complex methods to detect information manipulation in state estimation programs, this paper uses the weakness of the program when the correct information is entered. To end the evaluations, the proposed cyber-aware ATC algorithm is tested on a realistic utility network. Based on the simulation results, in spite of improvement in state estimation execution time, the quickness of ATC calculation is somewhat heightened when applying the proposed method of weighted least squares.

4:30 *MPPT Design Using PSO Technique for Photovoltaic System*

Ahmad Asri Abd Samat (Universiti Teknologi Mara Cawangan Pulau Pinang, Malaysia); Nor Aziyah Bakhari, Muhammad Nur Syahid Khairi and Nornaim Kamarudin (Universiti Teknologi MARA, Malaysia); Mohd Huzaimi Md Hussin (Politeknik, Malaysia); Aimi Idzwan Tajudin (Universiti Teknologi MARA, Cawangan Pulau Pinang, Malaysia)

This paper aims to design the MPPT technique using the Particle Swarm Optimization (PSO) method to track the maximum power at the photovoltaic (PV) system. The direct current (DC)-DC buck converter is used to control the solar PV power. The buck converter operates in both MPPT mode and voltage control mode. The voltage control mode is used only when load power is greater than the maximum power generated by the solar PV plant given the incident irradiance and panel temperature. First, the buck converter was designed based on the specification of the PV panel, and then the design will be modeled using Matlab/Simulink software. After that, the MPPT technique using the PSO method was designed and implemented in the system to track the maximum power. Based on the results obtained, it was found that the PSO parameter had an important effect on the accuracy of the system. The power point of the PV system can be tracked on constant and variations values of irradiances. From the result obtained, it can be concluded that, the efficiency of the PSO to track the maximum power is more than 90 % at 200 W/m2 and 700 W/m2 of irradiance. While at 1000 W/m2 the efficiency to track the maximum power is less than 90 %.

Tuesday, March 7

Tuesday, March 7 8:00 - 9:00

Registration & Light Refreshment

Tuesday, March 7 9:00 - 10:15

Forum: "Smart City: Malaysia Experience" by Panel 1: Dr. Lim Seng Boon (UiTM Perak) & Panel 2: Mr. Mohd Khairun Nizam Mohd Sarmin (TNBR))

Room: Irama 5
Chair: Kanendra Naidu (Universiti Teknologi MARA, Malaysia)

Tuesday, March 7 10:15 - 10:30

Coffee break 1

Tuesday, March 7 10:30 - 12:30

Session 2_1 (virtual): Power System Operation and Planning/ Smart Grid/Energy and Environment in Power Engineering Application

Room: Irama 5
Chair: Wan Noraishah Wan Abdul Munim (Universiti Teknologi MARA, Malaysia)

10:30 *Power Distribution Network State Monitoring Using Compressive Sampling*

Yuanchun Tang, Cui Li and Zhaozheng Zhou (State Grid Fujian Economic Research Institute, China)

The application of renewable energy sources complicates the distribution network structure, that raises requirements on a large number of sensors for state monitoring of the network, which causes big challenge on data transmission. Thus a compressive sampling method is proposed in this paper for decreasing the sampling and transmission data of current of the power line. In this method, the discrete cosine transform was first used as orthogonal basis for signal decomposition, then the random Gaussian matrix was applied as the measurement matrix for observation. Finally the signal was reconstructed based on the convex optimization method with L1 parametrization. Simulation results show that the

number of sampling points of current at a single node using proposed compressed sampling method could achieved 91.9472% less than the number using Nyquist sampling method. Furthermore, The compressed signal can be reconstructed at the distribution network sub-station, and the RMSE is only 0.5185, which greatly reduces the data required to be transmitted for grid line monitoring and reduces the communication network load to a certain extent.

10:45 ***A Multi-View Clustering Based Dynamic Partitioning Method for Distribution Network***
Cui Li, Bingsen Xia and Zhenglong Leng (State Grid Fujian Economic Research Institute, China)
Aiming at solving the division problem of the area-centralized layout in the power distribution network, a dynamic partitioning method of distribution network area based on a multi-view clustering algorithm is proposed. Firstly, a mathematical model is established to calculate the optimal number of clusters considering communication quality and communication cost. Secondly, the Laplace matrix of distribution network structure and other perspectives, such as the geographic location and the region of distribution network terminals are introduced to the distribution network area division by multi-view clustering. Thirdly, one of the terminals is selected as the edge computing center to ensure efficient edge computing by combining the clustering center and the actual situation. Finally, the proposed method realizes the effective partitioning of the distribution network and the automatic area adjustment when the structure of distribution network changes. Based on the network structure calculation of 145 terminals in a local distribution network, the experimental simulation results verify that the proposed partitioning method is practical and feasible.

11:00 ***Three-Phase Power Transformer Fault Diagnosis Based on SVM and BEES Algorithm***
Othman T E Abdusalam (Wolfson Centre for Magnetics & Cardiff University, United Kingdom (Great Britain))
In this paper, a new method is presented for the classification of current signal faults in three-phase transformers. In this method, Support Vector Machines are used in two different ways. The SVM1 is used for identifying faults and inrush currents in 3- phase transformers, whereas SVM2 is used to determine whether faults are internal (turn-to-turn faults and turn-to-ground) or external. In a laboratory-built transformer system with internal and external faults, the developed model was tested against inrush currents and several types of fault conditions. The data gathered on current signals were used to develop a proposed model. By training machine learning classifiers to detect faults by SVM, a process for optimal feature identification has been proposed. To extract statistical characteristics from unprocessed data, a discrete wavelet transform was used. An optimized subset was then created using the Bees algorithm (BA), which minimized the amount of data needed and improved the model's accuracy. 5k-fold cross-validation was used to train these models. This model has been analyzed based on accuracy. The study compares SVMs to ANNs-based classifiers and finds that SVMs are more reliable and provide faster results.

11:15 ***Communication Network Selection for Distribution Network Based on Analytic Hierarchy Process***
Wei Ge (Beijing University of Posts and Telecommunications, China); Qi Wei (State Grid Economic and Technological Research Institute CO. LTD., China); Weijun Hong and Yuchen Wu (Beijing University of Posts and Telecommunications, China); Cui Li (State Grid Fujian Economic Research Institute, China)
The access of large-scale distributed new energy has high requirements for the protection of new distribution network and communication network, but the selection of the communication network has no definite standard. In this paper, a communication network selection mechanism based on Analytic Hierarchy Process (AHP) is proposed to solve the problem of smart grid communication network selection. This method is based on the principle of decision-making analysis combining qualitative and quantitative analysis of multi-objective complex problems. The weight of indexes at all levels are calculated by the judgment matrix. After the consistency test, the overall judgment matrix is calculated to select the best scheme, which achieves the effect of decomposing and analyzing the communication network of distribution network. Through the analysis of 5 kinds of communication networks, namely optical fiber communication network, 4G network, 5G network, wireless private network and power line carrier, this research constructs the AHP model with accessibility, coverage, economy, reliability and security as the main parameter indexes, and obtains that 5G is the optimal scheme with 26.0178% of the comprehensive weight. Therefore, 5G network is more suitable for the application in the distribution network under the current new energy access.

11:30 ***Accelerant Facilitation for an Adaptive Weighting-Based Multi-Index Assessment of Cyber Physical Power Systems***

Steve Chan (Harvard University, USA); Parnmook Nopphawan (Vit Tall Special Projects Unit, USA)

Assessment methodologies for Cyber Physical Power Systems (CPPS) have often leveraged a Multi-Index Assessment Framework (MIAF) approach, whose Multi-Criteria Decision Making (MCDM) problems have various competing objectives and/or attributes that need to be optimized concurrently; yet, the involved Adaptive Weighting Methodology (AWM) has often been beset with selection bias (e.g., particular indices utilized, heuristics formulated, parameters selected, etc). A mitigation approach, among others, is to use an AWM that considers/hybridizes various subjective and objective approaches. For example, a bespoke Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)-CRiteria Importance through Intercriteria Correlation (CRITIC) et al. hybridized construct (C#1) conjoined with a bespoke R-Fuzzy Set (RFS), Adaptation of the Grey Relational Analysis (AGRA), and New Normalized Projection Entropy Weighting Model (NNP-EWM) et al. construct (C#2) can reduce the selection bias within the involved MIAF. Along with AGRA, C#2 can leverage Type-2 Fuzzy Sets (T2FS) and Spherical Fuzzy Set (SFS) AWM-derived entropy weights to better operationalize the AWM. This paper facilitates the C#1 and C#2 constructs with an Extended Matrix Shanks Transformation Accelerant (EMSTA) and enhances the efficacy of the MIAF for use with CPPS, particularly those which are potentially vulnerable to a Sequential Topology Attack (STA) effectuated by an Advanced Persistent Threat (APT) Insider Threat Paradigm (ITP).

11:45 ***Mixed-Integer Linear Programming (MILP) Approach for Solving Derating Problems in Optimization of Thermal Power Plants Operation Considering Primary Energy Uncertainty***

Nur Fauziyah (Bandung Institute of Technology, Indonesia)

Electricity has an important role in economic development and people's lives in a country. As the population increases, so does the demand for electricity, resulting in the problem of shortages of electricity supply which leads to huge economic losses. The important problem to be considered is the primary energy used to produce electricity, especially coal, one of the primary energies of thermal power plants where coal availability has a contribution to the non-optimal scheduling of thermal power plants operation which causes the derating problems. This paper proposes a new algorithm with combining algorithms of unit commitment and economic dispatch, coal transshipment, coal blending and inventory problems which will be implemented using Pyomo based on Python programming language with Mixed Integer Linear Programming (MILP) approach. The new algorithm is used to determine the optimal time for coal delivery and maintenance of power plants according to coal inventory. The results showed that the addition of this new algorithm provides 5.57% cheaper and more optimal power plants operation cost.

12:00 ***Resource Allocation for NOMA/IRS Network with Energy Harvesting in Presence of Hardware Impairment***

Thi Anh Le and Thuc Xuan Kieu (Hanoi University of Industry, Vietnam); Lam Ho Truong (Telecommunication Technical College, Vietnam); Hong Nguyen Thi (Posts and Telecommunications Institute of Technology, Vietnam)

In this paper, we study the impacts of hardware impairment of cooperative non-orthogonal multiple access (NOMA) with an assistant of an energy-harvesting (EH) relay network and an intelligent reflecting surface (IRS) on both energy efficiency (EE) and sum data rate (SDR) metrics. Specifically, in our proposed system, a base station communicates with two NOMA users via the assistance of the selected EH relay employing a power-splitting (PS) architecture. This EH technique is also used in this system to prolong the lifetime of relaying nodes. Moreover, to enhance the performance of our system, an algorithm of swarm intelligence as particle swarm optimization (PSO) is applied to maximize the value of EE and SDR under the constraint conditions of power allocation for each NOMA user. In addition, in this paper, the influence of key parameters of the system is investigated for two cases as IRS and without IRS models in composing of hardware impairment, the number of IRS elements, the number of IRS elements and intermediate nodes, and energy harvesting efficiency on both EE and SDR.

Session 2_2 (f2f): Renewable Energy and Storage/ Internet of Thing (IOT) in Power Engineering Application/ Energy and Environment in Power Engineering Application

Room: Irama 6
Chair: Kanendra Naidu (Universiti Teknologi MARA, Malaysia)

10:30 *Development of Prototype Photovoltaic-Thermoelectric Generator (PV-TEG) Hybrid System*
Siti Amely Jumaat (Universiti Tun Hussein Onn Malaysia, Malaysia); Wong Chin Khang (UTHM, Malaysia); Muhammad Akmal Johar (PETRONAS, Malaysia); Umar Abubakar Saleh (University Tun Hussein Onn Malaysia & Centre for Atmospheric Research, NARSDA, Prince Audu Abubakar University Anyigba, Kogi, Malaysia)
This paper presents the development and performance of Photovoltaic-Thermoelectric Generator (PV-TEG) Hybrid System in terms of voltage, current and power generated. The PV-TEG Hybrid System comprise a one (1) unit of 12V 3W PV module, nine (9) pieces TEG modules and two (2) heat sinks as cooling unit for TEG. The TEG modules put back-to-back to PV panel and this configuration used to decrease the temperature PV panel and solve the heat waste problem. The TEG module uses heat energy to generate energy, and this can improve the performance of PV-TEG Hybrid System. This experiment carried out in three days to collect the data. These findings show that the PV-TEG Hybrid System had better performance than stand-alone PV system

10:45 *Development of Automated Nutrient Composition Control for Fertigation System Using IoT Application*
Siti Amely Jumaat, Ahmad Fateh Mohamad Nor, Nur Hanis Mohammad Radzi and Muhammad Aliff Danial Bin Azman (Universiti Tun Hussein Onn Malaysia, Malaysia)
This paper is development of solar power automated nutrient composition control for fertigation system. The automatic mixing system that is controlled by Arduino Uno board. There are three 30 litre buckets for water and a stock of fertilizer A and B and one 10 litre tank for mixing. Three units of 12V DC water pumps will be used for fertilizer A, B and water and two more units will be used in this system to control water flow to the chosen crops. The solar power supply used consists of a 3 Watts mono-crystalline photovoltaic (PV) solar panel, 12/24V 10A solar charger controller and a 12 V rechargeable li-on battery. EC meter which is Analog EC Meter SKU: DFR0300 EC sensor module will be used as sensor to read the value of EC. Relay will be connected to water pump as its function is aim at controlling the opening and closing of the circuit contacts of an electronic circuit. The data of nutrient EC from Arduino Uno will transfer to NodeMCU ESP8266 and will be stored in Blynk application as implement of Internet of Things (IoT). The EC meter must react to the automated mixture nutrient with desired EC and the solution must flow to the chosen crops based on user desire which are chili plant or eggplant.

11:00 *Determination of Excitation Current Range to Reduce Self-Heating Using LTSpice for Resistance Temperature Detector in Aircraft System*
Puteri Sarah Mohamad Saad, Amirudin Ahmad Tazlan and Hashimah Hashim (Universiti Teknologi MARA, Malaysia)
One of the typical sensors used in aircraft to monitor a wide range of temperatures is Resistance Temperature Detector (RTD). But because it will compromise the precision of the temperature data, self-heating error has grown to be a significant issue for all temperature sensors, including RTD. Increased excitation current is the main reason self-heating issue occurs. In order to reduce the self-heating inaccuracy in RTD, this paper's goal is to examine the excitation current range. To replicate the excitation current that was injected into the Pt 100 RTD (Platinum RTD Standard IEC 751 Class B) and does affect the self-heating error, an experimental technique and comparison with theory were employed in this work. The average excitation current ranges from the experiment, which was carried out at temperatures between -200 °C and 850 °C, is 0.7992 mA to 5.4066 mA, and the self-heating error is between 0.0370 °C and 2.3665 °C. Additionally, 1.85 mA offers as the optimal excitation current at all temperatures.

11:15 ***Techno-Economical Analysis of Hybrid PV System for School Industry***

Muhammad Rezeki Akbar, A. Aripriharta and Alfian Mizar (Universitas Negeri Malang, Indonesia); Muladi Muladi (State University of Malang & Universitas Negeri Malang, Indonesia); Yu-Ching Hung (Universiti Teknikal Malaysia Melaka, Malaysia); Muhammad Adib Amin (Universitas Negeri Malang, Indonesia)

The rapid development of electricity consumption needs to be balanced with infrastructure development, one of which is the mix of fossil energy with new and renewable energy. Solar energy is one type of renewable energy that is abundant, pollution-free and supported by well established technology. This paper discusses the technical and economic analysis of one type of solar power system, namely a hybrid which is applied to a boarding school scale. The design of this hybrid system requires 10 solar modules with a capacity of 120 wp, 1 5 kW inverter, and 4 units of 12 V/200 Ah batteries. The initial investment cost for this solar power generation system is 22,398,435 rupiah. The analysis of the feasibility of investing in a solar power generation system shows a positive Net Present Value (NPV) of 32,208,93095 rupiahs. Internal Rate of Return (IRR) 10.0171% and Profitability Index (PI) 1.001437999. The NPV, IRR, and PI values show positive values, so the investment for this solar power generation system project can be said to be feasible. Meanwhile, the payback period is achieved in the 9th year of project operation.

11:30 ***A Comprehensive Study on the Renewable Energy Integration Using DIgSILENT***

Mostafa Eidiani (Khorasan Institutr of Higher Education, Iran); Hossein Zeynal (Buein Zahra Technical University, Iran); Zuhaina Zakaria (Universiti Teknologi MARA, Malaysia)

Renewable energy sources (RES) are growing rapidly as a result of energy security requirements and the environmental concerns. In spite of their many advantages, they yet pose many challenges to power grid operation. Therefore, appropriate rules and regulations ought to be formulated regarding the integration of these new sources into existing power grids. A comprehensive study of renewable energy systems integration using DIgSILENT PowerFactory software is conducted in this work. In presence of RES, the reliability and energy adequacy indicators of the network are investigated first. Furthermore, the energy storage systems, island mode, short circuit analysis, and probability analysis are assessed. More, harmonic analysis of RES in presence of unbalanced and balanced states is performed as well. A typical IEEE distribution system is employed to end the simulation analysis.

11:45 ***Educational Building's Energy Consumption Independent Variables Analysis Using Linear Regression Model: A Comparative Study***

Rijalul Fahmi Mustapa (Universiti Teknologi MARA, Malaysia); Atiqah Hamizah Mohd Nordin (Univerisiti Teknologi MARA, Malaysia); Muhammad Asraf Hairuddin (Universiti Teknolog MARA, Malaysia); Wan Suhaifiza W Ibrahim (Universiti Teknologi MARA Sarawak, Malaysia); Siti Aliyah Mohd Saleh (UITM, Malaysia); Nofri Yenita Dahlan (Universiti Teknologi Mara Malaysia, Malaysia); Ihsan M. Yassin (Universiti Teknologi Mara, Malaysia)

Baseline energy model is a model that relates the the energy consumption with its respective independent variables in a building. Prior to modelling, the selection of the independent variables was deemed important as it is the factor that governed the energy consumption. Without a proper analysis in selecting the independent variables, the development of the baseline energy model will suffer with impracticality and inaccuracy in prediction. Thus, this paper main objective is to analyze the independent variables that may affect the energy consumption in educational building before a baseline energy model will be developed. Single Linear Regression (SLR) model and Multiple Linear Regression (MLR) model will be used for the analysis purpose. Energy consumption data and independent variable data will be fed into the models. The coefficient of correlation (R) and coefficient of determination (R2) value will be use to analyze the strength of the independent variables towards the energy consumption. Results show that the MLR model has a high value of R and R2 0.91 and 0.84 respectively compared to SLR model that indicates more than one independent variables is affecting the energy consumption. Baseline energy models were developed from the SLR and MLR model where for the future work, energy consumption can be predicted using the baseline energy model.

12:00 *Combustion Consumables Cost Analysis in 110 MW Gross CFB Type CFPP Biomass Co-Firing Application*
Alfian Muhammad Reza, Fuad Chariri, Maulana Rifaldi, Ade Okta Yurwendra, Andal Adhi Prakoso and Fazrai Ari Habibi (PT PLN Enjiniring, Indonesia)
Biomass co-firing has become preferable to increase Indonesia's Renewable Energy share by 23% in 2025. Among all biomass co-firing tests, several were tested in CFB boiler type CFPP. CFB boiler is known for its capability to burn a wide range of fuel. This study took CFB as the boiler type, two coal variables which are normal and high-sulfur coal. And the biomass is palm kernel shell (PKS) with a ratio of 0 to 30% from fuel. The price gap between coal and biomass is still becoming a challenge to operate biomass co-firing where biomass price is nearly two times that of coal price. However, it was obtained that biomass co-firing will reduce the SO2 emission, then the limestone needs to desulfurize can be decreased. PKS co-firing could result in fewer desulfurization consumables operational costs. It can reduce the additional cost effect influenced by fuel switching to biomass.

Session 2_3 (f2f): High Voltage Engineering & Technology/ Data Analytics in Power Engineering Application

Room: Irama 7
Chair: Faranadia Abdul Haris (University of Technology MARA, Malaysia)

10:30 *Structure and DC Breakdown Properties of Polypropylene/Elastomer Blends*
Siti NoorHazirah Kamarudin (Malaysia Technology University, Malaysia); Kwan Yiew Lau (Universiti Teknologi Malaysia, Malaysia); Noor Azlinda Ahmad (Institute of High Voltage & High Current, Universiti Teknologi Malaysia, Malaysia); Nur Azalia Azrin and Chee Wei Tan (Universiti Teknologi Malaysia, Malaysia); Kuan Yong Ching (University of Reading Malaysia, Malaysia)
Thermoplastic materials, such as polypropylene (PP), are highly favored for usage as high voltage cable insulation systems due to their high melting temperature and flexible mechanical and electrical characteristics. In this regard, PP has the capability to replace standard crosslinked polyethylene (XLPE) as a future high voltage insulating material. Recently, the addition of elastomers into PP is being extensively investigated. This paper reports the effect of using different types of elastomers, at 10 wt%, on the structure and DC breakdown properties of PP blends. Fourier transformed infrared spectroscopy (FTIR) was performed to analyze the chemical structures and DC breakdown testing was carried out to evaluate the DC breakdown characteristics of the PP blends. From the breakdown results, PP blended with different types of elastomers had different values of DC breakdown strength, even though the amount of elastomers was kept the same at 10 wt%.

10:45 *Effect of Elastomer Content on AC Breakdown Performance of PP Blends*
Siti NoorHazirah Kamarudin (Malaysia Technology University, Malaysia); Kwan Yiew Lau (Universiti Teknologi Malaysia, Malaysia); Noor Azlinda Ahmad (Institute of High Voltage & High Current, Universiti Teknologi Malaysia, Malaysia); Nur Azalia Azrin (Universiti Teknologi Malaysia, Malaysia); Ahmad Basri Abd Ghani (TNB Research, Malaysia); Amira Arifin (TNB Research Sdn. Bhd., Malaysia)
Recently, many studies have been conducted on various dielectric materials, especially polymer/elastomer blends, with the aim of examining the materials' potential improvements in high voltage insulation. In particular, the interaction between the polymer and the elastomer acts an imperative role in the dielectric properties of the materials. Polypropylene (PP) has been blended with elastomers to improve their electrical and mechanical properties. In spite of this, adding elastomers to PP may negatively affect its electrical properties, making it a major challenge for PP modification. In this paper, a study on the morphology and AC breakdown performance of crosslinked polyethylene (XLPE), PP, and PP blends containing 10, 30, and 50 wt% of ethylene-octene copolymers (EOC) has been conducted. The morphological image results indicate uniform dispersion of EOC into the PP matrix. Although PP itself has the highest AC breakdown strength (169 kV/mm), adding up to 30 wt% of EOC to PP results in AC breakdown strength commensurate with that of eXLPE (145 kV/mm). This indicates the promising use of the PP/EOC blend in replacing XLPE with respect to morphological and AC breakdown properties.

11:00 ***Structure of Polypropylene, Ethylene-Propylene-Diene-Monomer and Magnesium Oxide for the Formulation of PP Blend Nanocomposites***

Nur Atikah Johari and Kwan Yiew Lau (Universiti Teknologi Malaysia, Malaysia); Zulkurnain Abdul-Malek (Universiti Teknologi Malaysia & Institute of High Voltage and High Current, Malaysia); Mona Riza Mohd Esa, Chee Wei Tan and Razman Ayop (Universiti Teknologi Malaysia, Malaysia)

In the realm of dielectrics, polypropylene (PP) has lately been suggested as a reasonable replacement for cross-linked polyethylene (XLPE) due to PP's advantageous characteristics of high durability under heat stress of 150 °C and its ease of recycling when compared to XLPE. Nevertheless, high-voltage cable insulation cannot be extruded from PP because it is stiffer than XLPE. When compared to XLPE, PP has a lower thermal conductivity at room temperature, which would normally lead to poorer dielectric characteristics. As a result, PP needs to be changed in order to change both its physical and electrical properties. This investigation suggested PP and ethylene-propylene-diene monomer (EPDM) to be blended to create a PP blend with less overall stiffness. The work included characterizing the structure and the thermal behavior of the raw materials including PP, EPDM, and magnesium oxide (MgO). Several investigations involving thermogravimetric analysis (TGA), Fourier transform infrared spectroscopy (FTIR), and differential scanning calorimetry (DSC) were used to characterize the PP, EPDM, and MgO. The results showed that all the materials are thermally stable and appropriate for formulating PP blend nanocomposites.

11:15 ***Direct Current Breakdown Properties of Polypropylene Nanocomposites Containing Magnesium Oxide***

Nur Atikah Johari and Kwan Yiew Lau (Universiti Teknologi Malaysia, Malaysia); Zulkurnain Abdul-Malek (Universiti Teknologi Malaysia & Institute of High Voltage and High Current, Malaysia); Mona Riza Mohd Esa, Chee Wei Tan and Razman Ayop (Universiti Teknologi Malaysia, Malaysia)

Polypropylene (PP) has promising electrical insulation properties as with its high thermal stability and voltage breakdown strength. Nevertheless, PP has a high degree of rigidity, making it difficult to be utilized directly as cable insulation. In this experimental work, ethylene-propylene-diene monomer (EPDM) has been mixed with isotactic polypropylene (PP) and the brittleness property of PP has been successfully modified. A nanofiller of magnesium oxide (MgO) has been embedded in a 50% PP and 50% EPDM blend. The various low loadings of MgO have been added to PP/EPDM nanocomposites to enhance the thermal and direct current (DC) breakdown strength of PP/EPDM nanocomposites. It reveals that the melting behavior of PP/EPDM nanocomposites is stable even after the addition of MgO. On the other hand, the addition of MgO greatly impacts the DC breakdown strength of the nanocomposites. To achieve the desirable electrical properties, the optimum content and dispersion of nanoparticles are crucial factors to be considered carefully.

11:30 ***The Impact of Cavity Size on Electric Field Distribution and PD Inception Voltage in Epoxy-Resin Insulation***

Umar Musa (Ahmadu Bello University-Zaria, Nigeria); Mohamad Nur Khairul Hafizi Rohani (Universiti Malaysia Perlis, Malaysia); Abdullahi Abubakar Mas'ud (Jubail Industrial City & Jubail Industrial College, Saudi Arabia); Bashir Dauda Aliyu (Ahmadu Bello University Zaria, Nigeria); Firdaus Muhammad-Sukki (Edinburgh Napier University, United Kingdom (Great Britain))

Cavities in insulation systems of active high voltage (HV) equipment affect their performance, reliability and useful life periods. Cavities serves as flash points for enhanced field activity leading to ageing from partial discharge (PD) events and subsequent breakdown of the insulation material. In this paper, the impact of cavity diameter on the electric field distribution as well as PD inception voltage is investigated in an Epoxy-resin insulation sample. A 3D adequate model of the sample with a spherical cavity was created and simulated in COMSOL for different cavity sizes and applied voltage stresses respectively. The simulation results indicate that the both field distribution and the PD inception voltages are strongly influenced by cavity size as well as the applied voltage magnitude. The electric field intensity was observed to be higher in cavities with smaller diameter relative to the insulation bulk, while the inception voltage decreases with increase in the cavity diameter and vice-versa.

11:45 ***Application of Over-Sampling Techniques and Fuzzy ARTMAP to Condition Monitoring of a Power Generation System***

Timothy Zhi Wei Chang, Shing Chiang Tan and Kok Swee Sim (Multimedia University, Malaysia); Chee Peng Lim (Deakin University, Australia); Pey Yun Goh (Multimedia University, Malaysia)

Condition monitoring is a process of assessing the health status of a system, process, or machine. Monitoring and identifying any potential fault can be conducted by leveraging measurements from the installed sensors that provide information on the state of the system. In this respect, machine learning models are useful for processing and analyzing the sensor data for fault detection. However, the imbalanced nature of these sensory data can cause misleading high accuracy scores. In this study, we employ an over-sampling method to tackle the imbalanced class problem. Specifically, both Synthetic Minority Over-sampling Technique (SMOTE) and Gaussian SMOTE are used to generate minority class samples. The balanced data set is used by the Fuzzy ARTMAP (FAM) model for fault classification. The effectiveness of the developed method is evaluated using a real-world circulating water system in a power generation plant. The results indicate that both SMOTE variants can improve the performance of FAM in detecting faults corresponding to operating conditions of the circulating water system for efficient power generation.

12:00 ***Health Index Prediction Using Artificial Neural Network (ANN) on Historical Data of Power Transformer***

Gemelfour Ardiatus Sudrajad (Institut Teknologi Bandung & PT. Petrolab Services, Indonesia)

Power transformer is an important equipment in the electric power system. The power transformer has the main task of changing the voltage, transmitting electricity, and distributing electricity. Disruption or failure of the transformer can result in asset fires and power outages. Transformer power failure can result in social and economic losses. The right maintenance strategy can reduce the risk of transformer failure and optimize operational costs and maintenance costs. The Health Index is used to provide an overall assessment of the condition of the power transformer, assess the reliability of the power transformer, and the strategy for maintaining the power transformer. In addition to durability, the health index of the transformer can be assessed from the life expectancy of the transformer. Health Index values can be obtained from expert judgment, calculations, and prediction methods using Artificial Intelligence. This paper discusses the implementation of Artificial Neural Network (ANN) as one of the Artificial Intelligence (AI) algorithms to predict the condition of the transformer health index. The result is compared to the calculated HI, then validated by 79 transformers that have been comprehensively assessed by the expert. Keywords- Power transformer, Health Index, Expected life transformer, and Artificial Neural Network

12:15 ***Comparison of Enhanced Isolation Forest and Enhanced Local Outlier Factor in Anomalous Power Consumption Labelling***

Rawan Mohammed Elhadad (Multimedia University, Malaysia); Yi-Fei Tan (Faculty of Engineering, Multimedia University, Malaysia); Wooi-Nee Tan (MMU, Malaysia)

Anomaly detection in power consumption is one of the major challenges faced by the modern world in response to the excessive electric consumption in developing countries. As a result, researchers were motivated to conduct extensive studies in this area to develop algorithms that classify the abnormal data instances from smart meter readings. In this paper, we examine and compare the effectiveness of two anomaly labelling algorithms, namely: the Enhanced Isolation Forest (E-IF) and the Enhanced Local Outlier Factor (E-LOF), in detecting the abnormal power consumption in building. The E-IF and the E-LOF are proposed based on the Isolation Forest (IF) and the Local Outlier Factor (LOF) algorithms with an additional step of applying a threshold to distinguish the high and low electricity consumptions anomalies. Experiments were performed to 10 smart meters readings and the capabilities of E-IF and E-LOF in detecting the injected anomalies were investigated. The results showed that the E-IF outperformed E-LOF, with E-IF managed to detect 100% of the injected anomalies at contamination levels of 0.30 and 0.35. The E-LOF, on the other hand, could detect an average of 68% of the injected anomalies for contamination level of 0.30 and 78% for contamination level of 0.35.

Tuesday, March 7 12:30 - 2:15

Lunch break

Tuesday, March 7 2:15 - 3:30

Session 2_4 (virtual): Renewable Energy and Storage

Room: Irama 5
Chair: Elia Erwani Hassan (Universiti Teknikal Malaysia Melaka, Malaysia)

2:15 *ANFIS-Based New Approach for an Optimal Lithium-Ion Battery Charging Control*
Salam S Hussein, SSH, Ahmed J. Abid and Adel Obed (Middle Technical University, Iraq)
Lithium-ion rechargeable batteries are considered one of the most energy storage batteries that are used in several portable electrical devices at present. Unwise charges of lithium-ion batteries can damage or reduce the battery life. Charging methods are several but may conflict with manufacturers- recommendations which leads to shortening battery life and reduced efficiency. This paper presents an ANFIS system that controls fast charging based on manufacturer recommendations using the CC-CV (Constant Current and Constant Voltage) method on Lithium-Ion batteries. The ANFIS model has been trained based on the recommendations of the manufacturer. Based on the simulation results, the proposed system offers accuracy in the matter of current is 1.28 mA (0.044% of the total capacity).

2:30 *Artificial Neural Network Prediction to Identify Solar Energy Potential in Eastern Indonesia*
Dharma Aryani (State Polytechnic of Ujung Pandang, Indonesia); Sarwo Pranoto (Universitas Negeri Yogyakarta, Indonesia); Fajar Fajar (Politeknik Negeri Ujung Pandang, Indonesia); Firza Zulmi Rhamadhan (PT PLN Nusantara Power, Indonesia); A. Nur Intang (State Polytechnic of Ujung Pandang, Indonesia)
The geographic location of Indonesia which climates almost entirely tropical provides exclusive potential for solar energy all through the year. This paper performs identification and prediction of solar irradiance in Eastern area of Indonesia. Modelling and estimation approach is carried out by using Artificial Neural Network (ANN) algorithm. Datasets for training and testing are highly correlated parameters from NASA climatological database for 20 years of historical data. The results of training and testing procedures in ANN show high accuracy of solar modelling and prediction. The study produces spatial mapping of solar irradiance intensity for the monthly average solar irradiance of 174 districts in Eastern Indonesia region.

2:45 *A Review of Optimization Approaches for Optimal Location and Size of Battery Energy Storage System*
Siti Salwa Mat Isa (UiTM Pulau Pinang, Malaysia); Mohammad Nizam Ibrahim and Anuar Mohamad (Kolej Pengajian Kejuruteraan, UiTM Cawangan Pulau Pinang, Malaysia); Shahilah Nordin (Universiti Teknologi MARA, Malaysia); Nofri Yenita Dahlan (Universiti Teknologi Mara Malaysia, Malaysia)
Global warming and climate change are driven by increased carbon emissions due to industrialization, rapid population growth and a rise in fossil fuel consumption. Therefore, the power industry is switching to alternative energy sources including solar power (PV), wind power (WP) and battery energy storage systems (BESS). BESS is seen as a potential alternative to the issue of global warming owing to its advantages over conventional energy sources, such as fast and consistent response, versatility, manageability, eco-friendliness, and geographic independence. Numerous studies have been conducted to determine the optimal location and size of battery size using a variety of criteria and techniques. This paper presents a brief review of the battery energy storage system in terms of optimization approaches that have been used in various conditions such as installation in the microgrid, distribution network, for losses reduction, charging and discharging schedules as well as peak load demand. Overall, this paper makes a significant recommendation that would benefit researchers in developing a productive, powerful, efficient, and robust battery energy-storage system for a sustainable future.

3:00 *Hotspot Detection of Solar Photovoltaic System: A Perspective from Image Processing*
Nurul Huda Ishak (UiTM Pulau Pinang, Malaysia); Iza Sazanita Isa (Universiti Teknologi Mara, Malaysia); Muhammad Khusairi Osman (Universiti Teknologi Mara (UiTM), Malaysia); Kamarulazhar Daud (Universiti Teknologi Mara Cawangan Pulau Pinang, Malaysia); Shawal Shawal (Universiti Malaysia Pahang, Malaysia)
Solar energy has rapidly grown in research because of its significant and contributions towards renewable and clean energy technology advancement. Effective energy management such as fault detection impacts the early-stage

monitoring for the efficiency, reliability, and safety of solar photovoltaic (PV) systems. The formation of a hotspot is one of the problems that can occur in a PV system. However, the main limitation of difficulty in interpreting specific components with erratic temperatures in the thermographic has arisen for the intelligence detection model. In this study, a review of hotspot detection for solar PV panels using the image processing method is established based on the image processing field. Integrating the image processing approach can assist in developing automated fault detection in solar PV panels for effective preventive monitoring methods. Therefore, this aspect needs to be categorized and considered accordingly for achieving accurate prediction. Several ways were discussed, and future research is suggested in this study.

Session 2_5 (f2f): Power System Operation and Planning

Room: Irama 6
Chair: Jurifa Mat Lazi (Universiti Teknikal Malaysia Melaka, Malaysia)

2:15 *Optimized Allocation of Lightning Protection System Using PSOGSA*
Jia Wen Tang and Chin-Leong Wooi (Universiti Malaysia Perlis, Malaysia); Wen Shan Tan (Monash University Malaysia, Malaysia); Hadi Nabipour Afrouzi (Swinburne University of Technology Sarawak Campus, Malaysia); Syahrun Nizam Md Arshad (Universiti Malaysia Perlis (Unimap), Malaysia); Muzaidi Othman (Universiti Malaysia Perlis, Malaysia)
In this paper, the hybrid PSOGSA, which is a combined algorithm of Particle Swarm Optimization (PSO) and Gravitational Search Algorithm (GSA), is proposed to find the optimum locations for the lightning protection system on the 81-bus radial distribution system. Moreover, the System Average Interruption Frequency Index (SAIFI) is considered as the objective function and will be minimized. The main advantage of this work is the simplicity and convenience of finding an optimal solution using the proposed PSOGSA algorithm. Additionally, PSOGSA is also capable of finding the optimal locations for applying lightning protection system (LPS) in a distribution network, while minimizing SAIFI and maintaining computational efficiency. To validate the effectiveness of the proposed algorithm, numerical simulations are carried out considering the interdependency between lightning phenomena and the distribution feeder characteristics, namely, the flashover rates due to direct and induced lightning. In addition, a comparison between PSO, GSA, and PSOGSA is made to compare and validate the performance of the algorithms. The results show that the latter is better at escaping from local optima and has a faster convergence than the standard PSO and GSA. PSOGSA also managed to achieve a higher reduction of 12.10% SAIFI after applying LPS on the optimal feeders, as compared to the 10.79% and 11.77% reduction of SAIFI by GSA and PSO, respectively. PSOGSA also has a faster convergence speed than PSO.

2:30 *Determination of Optimal Distributed Generation Penetration Level in Distribution Networks Based on Normalized Impact Factor Score*
Muhammad Syahir Bin Turiman (TNB Research Sdn. Bhd., Malaysia); Mohd Khairun Nizam Mohd Sarmin and Nira Saadun (TNB Research, Malaysia); Mohd Fahri Zamri (Tenaga Nasional Berhad, Malaysia)
The penetration level of renewable energy (RE) including distributed generation (DG) integrated in the distribution network has been increasing in many countries. This follows widespread encouragement to use renewable energy to minimize reliance on conventional power plants to achieve net zero emissions. Malaysian energy transition targets and carbon neutral goals set by the government, lower cost of ownership of solar PV systems, and more efficient government renewable energy initiatives including Net Energy Metering (NEM) 3.0, Green Investment Tax (GITA), Large Scale Solar (LSS), and most recently the Corporate Green Power Program (CGPP) have driven the rapid development of renewable energy in the country. However, the high penetration level of distributed generation including solar PV, mini-hydro, and bio-energy has introduced several technical impacts on the operation of the distribution network including increased fault levels, voltage limit violation, reverse power flow, distribution network losses, and transformer losses. This paper analyzes the technical impacts of the high penetration level of distributed generation in medium voltage (MV) substations of the distribution network using DigSILENT PowerFactory simulation software. From the results obtained through the simulation analysis, the impact factors of fault level, voltage limit violations, reverse power flow, distribution network losses, and transformer losses have been formulated. The optimal distributed generation penetration level in distribution networks is then determined based on the highest score value of the normalized impact factor from all penetration levels.

2:45 *Power System Transient Stability Analysis Due to Various Contingencies Using PowerWorld Simulator*
Nur Ashida Salim and Mohd Endra Shafiq Ensnat (Universiti Teknologi MARA, Malaysia); Hasmaini Mohamad (University of Technology MARA, Malaysia); Zuhaila Mat Yasin (Universiti Teknologi Mara, Malaysia)
A change in load, switching operation, abrupt faults, and loss excitation are the causes of the transient disturbance. Therefore, it is crucial to regain synchronism or equilibrium upon disruptions to the electrical services. This paper focused on the analysis of transient stability of IEEE 9-bus system using PowerWorld Simulator. The Newton-Raphson approach will be used during the load flow studies to determine the pre-fault conditions in the system. The system's variation in rotor angle, frequency, and voltage will then be investigated with the use of a three-phase balanced fault. It is concluded for different contingency test, there will be rotor deviation, changes in frequency and changes in voltage in per unit. Additionally, the critical clearing time of the system will vary depending on the contingencies test. Investigating the stability of the power system during abrupt and large disturbances is done using transient stability analysis, which is crucial to preserving the safety of power system operation.

3:00 *Centralized Protection and Control (CPC): Next Level of Electrical Protection System Towards Digital Substation (Oil and Gas)*
Fitriah Binti Shafei, Salmey Bin A Halim, M Khairil Bin M Hatta, Husswan Hadi Bin W Hussein, Nur Azra Azmi and Faizah Binti Othman (PETRONAS, Malaysia)
This paper is prepared in line with IEEE publication requirements which describes the Centralized Protection and Control (CPC) as the new level of electrical protection system towards supporting digital substation. This paper is prepared with the intent to share about current industry challenges, the values brought by CPC, current efforts in realizing CPC, the requirements, aspiration, as well as the risk associated to CPC installation in oil & gas industry. Centralized Protection and Control or CPC is a protection system with the concept of relocating the functions and features that resides in a protection relay to a centralized device. As protection system is one of Safety Critical Element in Oil and Gas Industry. Operation and Maintenance (O&M) team is looking for features to operate and manage protection relay in a more advanced manner. As the technology evolved, the advancement of hardware capability allows for more computing power in a centralized device to process larger protection data and execute protection function. By having a centralized protection device, complete with digital database supported with analytical tools, and customized features, managing a wide range of protection relays in large scale electrical installation becomes easier and more efficient. Digitalization, centralization, remote monitoring and remote automation are the key step towards realizing digital twins of electrical protection system, thus supporting the reduction of operational costs in such facilities.

Session 2_6 (f2f): Energy and Environment in Power Engineering Application/Power System Operation and Planning

Room: Irama 7
Chair: Azrita Alias (University of Malaya, Malaysia)

2:15 *Impact of Incandescent Light and LED on Electricity Fee and Carbon Emission Cost at an Airport in Malaysia*
Wan Mohammed Rais Bin Jamaludin and Wan Mazlina Wan Mohamed (Universiti Teknologi MARA, Malaysia); Nik Hakimi Nik Ali (Universiti Teknologi MARA & Shah Alam, Selangor, Malaysia); Nor Azlina Binti Mohd Isa (Malaysia Airports Holdings Berhad, Malaysia)
Nowadays, the environment has been highly impacted by global warming and the greenhouse effect. Issues like carbon reduction, environmental protection and sustainability through energy saving have become common goals worldwide. The increasing usage of Aeronautical Ground Lighting (AGL) in airports have cause a high cost in electricity fee. Thus, the objectives of this paper are to assess the cost assessment model with respect to Malaysia's condition in terms of electricity fee with carbon emission cost.

The proposed model will be applied to an airport that accommodates night operations hours focusing on approach lights. Comparison between the lighting cost of a traditional light source (incandescent light) and an energy-saving light source (LED light) is conducted by using electricity fee and carbon emission cost formulation respectively. It is found that by using existing infrastructure and replacing the light source, LED can produce much lower electricity fee and carbon

emission costs. However, installing LEDs on existing electrical infrastructure may limit the amount of energy savings that can be achieved. In conclusion, this paper will benefit airport operators in Malaysia in determining the reduction of electricity fee and carbon emission by using LED.

2:30 *Optimal Placement of Distributed Generation and Capacitor in Distribution System for District Hospital in Malaysia*

Maizatul Shafiqah Sharul Anuar and Mohd Nabil Muhtazaruddin (Universiti Teknologi Malaysia, Malaysia); Mohd Azizi Abdul Rahman (Universiti Teknologi Malaysia & Malaysia-Japan International Institute of Technology, Malaysia); Mohd Effendi Amran (Ministry of Health Malaysia, Malaysia)

Recent advancement in power generation technologies using renewable energy resources and government policies toward a more sustainable future has called for more environmental incentive. The application of renewable-based distributed generation in a distribution system has gained significant recognition due to its technical and environmental benefits. In this paper, Artificial Bee Colony (ABC) algorithm will be used to obtain optimal location and sizing of both distributed generation (DG) and capacitor with power loss reduction as its main objective function. Four different cases will be simulated to observe the effectiveness of both DG and capacitor in reducing the power loss when it was installed together. The simulated result showed that installation of both DG and capacitor give the best results and objective function in this study which is power loss reduction was achieved.

2:45 *Correlation of the NOx Emission and Required Area for Designing SCR Facility in Gas Engine Power Plant Based on the Emission Regulation*

Alfian Muhammad Reza (PT PLN Enjiniring, Indonesia); Muhammad Susetyo (PT PLN Unit Induk Pembangunan Jawa Bagian Tengah I, Indonesia); Aga Batry Heksaprilla (PT PLN, Indonesia); Wismanto Setyadi (PT PLN Enjiniring, Indonesia)

To substitute existing power plants with cleaner and environmental-friendly fuel, developing a gas engine power plant (GEPP) is the most appropriate option. GEPP has a lesser emission than common fossil power such as coal-fired, gas turbine, and diesel engine power plants and currently is the best open cycle power plant. The mentioned emissions are nitrous oxide (NOx), sulfur dioxide (SO2), particulate matter (PM), and even carbon dioxide (CO2). This study emphasizes NOx emission as the object. Due to the necessity of more environmentally friendly energy sources in the future, NOx emission regulation may be stringent. Gas engines may need to install NOx reduction equipment such as selective catalytic reduction (SCR) and its facilities whenever it happens. The one that shall be considered is the chemical reactant storage which needs quite a large area to be applied. This study gives a perception to the design engineer of a gas engine power plant on how to estimate the additional space needed when NOx emission regulations become more stringent. The required area estimation will be in the function of ammonia injection dosage, engine specification, fuel specification, operational capacity factor, ammonia purity, and storage time, considering NOx emission regulation.

3:00 *Generation Expansion Planning Considering Photovoltaic (PV) and Wind Turbine Systems Using Optimization of Evolutionary Programming (EP) Technique*

Adibah Binti Mashudi (Power Engineering, Malaysia); Muhammad Murtadha Othman (Universiti Teknologi MARA, Malaysia); Masoud Ahmadipour (University Teknologi MARA & Universiti Teknologi MARA (UiTM) Malaysia, Malaysia); Kamrul Hasan (Universiti Teknologi MARA, Malaysia)

This project introduces generation expansion planning considering grid-connected PV Generator and Wind turbine allowing the reliability of a system. The Markov model is performed with embedded data of PV generator and Wind turbine to obtain forced outage rate (FOR). Then, a load of a 24-bus system and a variant number of the population comprising kW sizing of PV Generator and Wind turbine is used to obtain the loss of load expectation (LOLE). The EP technique for optimization of expansion planning considering Roulette wheel and crossover is applied to increase the performance of system reliability of PV Generator and Wind turbine. The generation expansion planning produced the best sizing of PV Generator and Wind turbine with the LOLE less than 2.4 and finally obtained the objective function which is the lowest installation cost.

Tuesday, March 7 3:30 - 3:45

Coffee Break 2

Tuesday, March 7 3:45 - 5:15

Session 2_7 (virtual): Power Electronics and Applications / Energy and Environment in Power Engineering Application

Room: Irama 5
Chair: Nur Ashida Salim (Universiti Teknologi MARA, Malaysia)

3:45 *Performance of Modified Structure Asymmetrical Multilevel Inverter with Multicarrier PWM Control Strategies*
Geno Peter (Sibu, 12 & SARAWAK, Malaysia); Arun Vijayakumar (Sreevidyanikethan Engineering College, India); Albert Alexander, S (Vellore Institute of Technology); Samat Iderus (UTS, Malaysia); Mukesh Soni (Chandigarh University, India)
The asymmetrical reduced switch single phase multilevel inverter (MLI) is presented in this paper. In comparison to a traditional multilevel inverter, the proposed topology uses fewer switches. Unipolar Multi Carrier Sinusoidal Pulse Width Modulation (UMCS-PWM) techniques are used to control an MLI. These pulse width modulation techniques encompass carrier overlapping (CO), alternate phase opposition disposition (APOD), and phase disposition (PD). The significance of key metrics like Total Harmonic Distortion (THD), VRMS (fundamental), crest factor, and distortion factor is assessed for several modulation indices. Simulation and experiments are used to illustrate the effectiveness of the suggested techniques. It is found that the UMCS-PDPWM method produces relatively low distortion output whereas the UMCS-COPWM strategy produces significantly greater fundamental RMS output voltage. The FPGA is used to implement the developed UMCS-PWM methods in real time. The results of the simulation and the experiment are often very comparable, which confirms the effectiveness of the suggested strategies.

4:00 *Sixty Degree PWM Scheme for Binary Source Asymmetrical Multilevel Inverter*
Arun Vijayakumar (Sreevidyanikethan Engineering College, India); Geno Peter (Sibu, 12 & SARAWAK, Malaysia); Albert Alexander, S (Kongu Engineering College, India); Samat Iderus (UTS, Malaysia)
This paper examines the sixty-degree reference PWM scheme with Asymmetrical Multilevel inverter (AMLI) structure that can synthesize 15 level voltage output. The triggering Pulse for AMLI are obtained using triangular carriers and a sixty-degree PWM reference. Various techniques exist for that as well, including Phase Disposition (PD), Alternate Phase Opposition Disposition (APOD), Carrier Overlapping (CO), and Variable Frequency (VF). Total Harmonic Distortion (THD), Root Mean Square (RMS) Voltage, Crest Factor (CF), Form Factor (FF), and Distortion Factor (DF) are some of the performance metrics used to evaluate for various modulation indices. Simulations are executed with "MATLAB-SIMULINK". The FPGA is used to perform real-time implementation of the proposed sixty-degree reference PWM schemes. The efficiency of the proposed strategies is confirmed by the significant degree of similarity between the simulated findings and the experimental findings.

4:15 *Perovskite PV MPPT Design for BIPV Applications*
Sanusi I Olatunji (Nazarbayev University, Kazakhstan); Arjuna Marzuki (Wawasan Open University, Malaysia); Annie Ng and Ikechi Augustine Ukaegbu (Nazarbayev University, Kazakhstan)
Globally, renewable energy consumption has expanded to avert environmental damage. Solar energy is expected to be the cornerstone of a sustainable energy economy since sunlight is so abundant. Perovskite solar cells (PSCs), which are incorporated into BIPVs' architectural envelope, reduce buildings' electricity needs, as well as improve the energy conversion paradigm to integrate PSCs and batteries. This paper aims to design and develop an MPPT circuit with a DC-DC converter (boost converter), and PSCs for the BIPVs Application. PSC's energy collecting technology uses P&O-based MPPT. This approach uses a Sample and Hold (S&H), flow chat, and multiplier circuit. P&O compares perovskite photovoltaic cells' maximum power points and open circuit voltages. Comparators, a compensator, and PWM drivers are

intended for battery and charging systems. Two case studies were considered to evaluate the performance of the PSC performance in natural and artificial illumination. This circuit is designed in a UMC 180nm CMOS Technology.

4:30 *Review of Artificial Neural Network Approaches for Predicting Building Energy Consumption*
Siti Solehah Md Ramli, Mohammad Nizam Ibrahim and Anuar Mohamad (Kolej Pengajian Kejuruteraan, UiTM Cawangan Pulau Pinang, Malaysia); Kamarulazhar Daud (Universiti Teknologi Mara Cawangan Pulau Pinang, Malaysia); Abdul Malek Saidina Omar (Universiti Teknologi MARA, Cawangan Pulau Pinang, Malaysia); Nur Darina Ahmad (Universiti Teknologi MARA Cawangan Pulau Pinang, Malaysia)
Recently, the forecasting of energy consumption has prompted a massive escalation in research studies that are being conducted all over the world in an effort to attain higher levels of sustainability. Forecasting is essential to decision-making for effective energy conservation and development within an organization. The adoption of data-driven models for energy forecasting has seen tremendous growth in the past few decades as a result of improvements in performance, robustness, and simplicity of deployment brought about by these improvements. There are various kinds of models, but Artificial Neural Networks (ANN) are currently among the most widely used data-driven methods that have been applied to real-world situations. This study provides a comprehensive overview of research on ANN and a comparison with other data-driven models and the evaluation metrics were employed to evaluate the performances of each technique. This review helps to outline potential future research in the area of data-driven building energy consumption prediction and prominence existing research gaps.

Session 2_8 (f2f): Electric and Hybrid Vehicles/ Power Electronics and Applications

Room: Irama 6
Chair: Hasmaini Mohamad (University of Technology MARA, Malaysia)

3:45 *Optimal Charging Scheduling of Electric Vehicle Considering Minimum Power Loss Using Firefly Algorithm*
Hasmaini Mohamad (University of Technology MARA, Malaysia); Norhasniza Md Razali (Universiti Teknologi MARA, Malaysia); Khairul Ikhwan Khairudin Shah (University of Technology MARA, Malaysia); Kanendra Naidu and Nur Ashida Salim (Universiti Teknologi MARA, Malaysia)
With growing concerns about environmental pollution, carbon dioxide emissions and reliance of fossil fuels energy, electric vehicles have received great attention due to clean and reliable energy supply worldwide. However, random charging of electric vehicles may lower the power system efficiency and affects its total stability. This paper presents an optimal coordinated charging of electric vehicle to achieve minimum power loss using computational technique i.e., Firefly Algorithm. The proposed algorithm considered some constraints such as the system's maximum load demand and voltage profile range and is tested on the IEEE 33-bus radial distribution network. The results are compared between the base load, uncoordinated and coordinated charging. The coordinated charging scheduling is further analyzed by varying the charging rate and observe its impact to the test network. The coordinated charging scheduling is also carried out using Evolutionary Programming and the convergence performance is compared to the proposed Firefly Algorithm. Results obtained show that the proposed algorithm achieves the optimization purpose by minimizing the power loss under a set of constraints.

4:00 *Dynamic Voltage Restorer (DVR) Using Supercapacitor for Power Quality Enhancement*
Justin Anak Tigong, Muhammad Murtadha Othman and Kamrul Hasan (Universiti Teknologi MARA, Malaysia); Masoud Ahmadipour (University Teknologi MARA & Universiti Teknologi MARA (UiTM) Malaysia, Malaysia)
In this study, the supercapacitor (SCAP) connected at the DC-link of the DVR is used to inject the voltage required to sustain the mitigation of the power quality problems incurred in a system. SCAP has the advantage of rapid power charge and discharge required by the DC-link voltage for immediate and sustainable mitigation of power quality. The output voltage transmitted from the DC link to the inverter is controlled by the bidirectional DC-DC converter and is depending on the type of power quality problem. Once the voltage sag is detected, the bidirectional DC-DC converter will operate in a boost mode. On the overleaf, the buck mode is operated when the voltage swell occurs. The proposed DVR-SCAP technique is performed by injecting the required voltage for mitigation into the system. MATLAB/Simulink platform is

utilized to exhibit the simulation results which validates the proposed DVR-SCAP configuration's compensation capability for the grid disturbances.

4:15 *Design of Inverter Aquaponic System with PV Supply*

A. Aripriharta, Arfienda Miawa Tyassilva, Rifqi Al Ihsan and Rui Alfadel Saputra (Universitas Negeri Malang, Indonesia); Saodah Omar (Universiti Teknologi Mara, Malaysia); Yu-Ching Hung (Universiti Teknikal Malaysia Melaka, Malaysia)

Aquaponics system is currently a trend among the people. Many communities are competing in the development of aquaponics systems. This is because the aquaponics system is a new and renewable energy development that is environmentally friendly. Utilization of solar energy as a source of electricity is one of the efforts to develop aquaponics system innovation. This concept is through energy from sunlight stored in solar panels and then converted into electrical energy for modern agricultural systems. This research involves a combination of electronics and agriculture as a sustainable system using solar panels, inverters, and water pumps. Solar panels are considered as an alternative in generating electricity, by producing an output voltage of 24V. The magnitude of this voltage value depends on the sunlight that is accommodated by the solar panel. Weather can affect the performance of solar panels in accommodating the amount of sunlight. The implementation of this project requires electrical energy from solar panels by utilizing an inverter to convert direct current (DC) into Alternative Current (AC) to increase the voltage from 24V to 220V.

4:30 *Power Quality Control Strategy of MMC Rectifier as Solid State Transformer in MVAC Network*

Kevin Gausultan Hadith Mangunkusumo (PLN Research Institute, Indonesia); Muhammad Ridwan (PLN Research Institute, Indonesia & PT. PLN (Persero) Pusat Penelitian dan Pengembangan, Indonesia); Roni Irnawan (Gadjah Mada University, Indonesia); Sriyono Sriyono (Institut Teknologi Bandung (ITB), Indonesia); Fransisco Danang Wijaya and Yohan Fajar Sidik (Universitas Gadjah Mada, Indonesia); Putri Prima Oktarina (Haleyora Power Indo, Indonesia)

The development of electricity technology in distribution networks such as Electric Vehicles and Distributed Generation (Rooftop PV, etc.) can lead to increased instability due to the characteristics of generation that tends to fluctuate and the characteristics of power electronic devices. Conventional transformers behave passively to the problems faced by the distribution network. One solution to this problem is the use of solid state transformers (SST). This study will describe the consideration of topology selection and rectifier control system as one of the main converters of SST. The rectifier topology used is Modular Multilevel Converter (MMCMMC is chosen because it has the flexibility of feature development and low THD compared to other converter topology options. The Higher Level Control algorithm used is Vector Current Control and the Lower Level Control uses Nearest Level control. Simulation results show that the MMC rectifier in the designed SST is able to support reactive power by sending and absorbing reactive power according to load demand or dispatch commands on the MVAC network. Moreover, the designed MMC rectifier is able to respond to the emergence of power quality problems in the form of voltage sag and swell.

4:45 *A New MBC-TSI Topology for Microinverter PV Application*

Atikah Razi (Universiti Teknikal Malaysia Melaka, Malaysia); Muhamad Nabil Hidayat (Universiti Teknologi MARA, Malaysia); Auzani Jidin and Syahar Azalia Ab Shukor (Universiti Teknikal Malaysia Melaka, Malaysia)

This paper presents the design of simulation model of the proposed Multilevel Boost Converter (MBC)-Three Switch Inverter (TSI) for Self-Consumption (SELCO) or known as microinverter in Off-grid Photovoltaic (OGPV) system. Individual PV without array combination is the applied rule towards Microinverter PV panel. The proposed MBC-TSI topology utilize only two isolated individual PV panel for a new approach toward two-stage microinverter (TSM) PV configuration. Conventional H-bridge topology with a total of 7 identical unit of PV panels and H-Bridge topology is taken for reference study aims for 230Vrms PV system with voltage gain almost the same with the proposed topology. The simulation model has been developed using MATLAB Simulink at Standard Test Condition (STC) with open loop switching technique adopted by implementing the switching signals produced by the pulse generator block. The steady-state simulation results show that the proposed MBC-TSI topology successfully generated a voltage gain, AV of 7.34 through reduced number of PV panel (2-unit PV instead of 7-unit PV from the reference study) and generated a balanced 3-level 230Vrms output with voltage and current harmonic percentage of 48.34% and 16.47% respectively. Thus, proved the proposed topology offering a new approach towards TSM in SELCO PV network.

Session 2_9 (f2f): Renewable Energy and Storage

Room: Irama 7
Chair: Zuhaila Mat Yasin (Universiti Teknologi Mara, Malaysia)

3:45 *Optimal Allocation of Photovoltaic (PV) System Incorporating Energy Storage System (ESS) Using Evolutionary Programming (EP) for Power System Reliability*
Sharifah Basyirah Syed Zainal Abidin (Power Engineering, Malaysia); Muhammad Murtadha Othman (Universiti Teknologi MARA, Malaysia); Masoud Ahmadipour (University Teknologi MARA & Universiti Teknologi MARA (UiTM) Malaysia, Malaysia); Kamrul Hasan (Universiti Teknologi MARA, Malaysia)
Net Zero Carbon 2050 requires a shift to renewable energy (RE) such as the photovoltaic system. However, the uncertainty of RE will cause electrical system interruptions, excess energy output, and a lack of electricity supply. Energy storage systems (ESSs) can be used to solve supply problems, but they should consider the reliability component of the power system. It is important to assess the impact of RE incorporated ESS for reliability studies. Optimal allocation of RE incorporating ESS needs to be tackled to ensure the grid failures and their impacts. This research shows the optimal allocation of RE with ESSs for power system reliability. The Force Outage Rate (FOR) for the energy storage system, photovoltaic system, and weather conditions was obtained from the development of each Markov model. Then, each FOR is combined to get the new FOR. The value of LOLE must be below 0.1 per year or 2.4 hours per year and the value of EUE should close to zero. Accordingly, this paper shows that the optimal allocation of PV incorporating ESS that minimizes the LOLE and EUE while satisfying the installation target and constraints on reliability indices.

4:00 *Optimal Allocation of Photovoltaic (PV) System Considering Weather Conditions Using Evolutionary Programming (EP) for Enhanced Power System Resiliency*
Nurul Thasyahirah Ellya Mohd Jailaini (Power Engineering, Malaysia); Muhammad Murtadha Othman (Universiti Teknologi MARA, Malaysia); Masoud Ahmadipour (University Teknologi MARA & Universiti Teknologi MARA (UiTM) Malaysia, Malaysia); Kamrul Hasan (Universiti Teknologi MARA, Malaysia)
This project introduces an optimal PV system allocation by considering weather conditions through a system reliability assessment. The Markov model is performed with embedded data of the PV generator and weather conditions to obtain a forced outage rate (FOR) and both (FOR) will be merged together to get a new FOR. Then, a load of a 24 Reliability Test System and a variant number of populations composed of PV system size is used to obtain the expected unserved energy (EUE) and loss of load expectation (LOLE). The EP technique for optimization is applied to determine the best sizing and generating unit (GU) of the PV system with the EUE close to zero and LOLE less than 2.4 hours per year. This paper used the effect of weather conditions on the PV system as a case analysis.

4:15 *Random Forest (RF) with Daubechies Wavelet and Multiple Time Lags (MTL) for Solar Irradiance Forecasting*
Raihanah Naja Redan, Muhammad Murtadha B. Othman and Kamrul Hasan (Universiti Teknologi MARA, Malaysia); Masoud Ahmadipour (University Teknologi MARA & Universiti Teknologi MARA (UiTM) Malaysia, Malaysia)
Accurate forecasting of solar irradiance is important as the dependency of this clean energy towards weather condition may affect the efficiency of solar power plant. Various types of models has been used to forecast solar irradiance and maintain the efficiency of solar power grid but not many can provide a high accuracy forecasting. In this paper, raw information of solar irradiance, current, temperature and power are collected as input for the random forest (RF) techique. These data went through a noise elimination process before it can use as input data for training and testing procedures. Daubechies wavelet based decomposition concept has been used in filtering the data from any unwanted noise as it may increase the percentage of error. The feature extraction of multiple time lags (MTL) is used to further improve the contents of input data. The proposed method used for solar irradiance forecasting is very much needed to reduce the forecasting error and useful for maintaining the stability of generated energy and energy consumption.

4:30 *Condition Monitoring Studies on a New Ellipse Shape Profile of Modified Savonius Wind Turbine with Quarter Cylindrical Rotor House*

Abdul Qoiyum Mohd Radzi (Politeknik Sultan Azlan Shah, Malaysia); Shamsul Sarip (UTM Kuala Lumpur, Malaysia); Mohd Nabil Muhtazaruddin (Universiti Teknologi Malaysia, Malaysia)

This paper aims to enhance the performance of four bladed modified Savonius wind turbine (SWT) for low wind speed. The new ellipse shape profile (NESP) Savonius rotor equipped with quarter cylindrical novel rotor house (NRH) as investigated in previous studies, was investigated using wind tunnel test. In the current study, the rotational speed of various rotor houses was monitored under high wind speeds ranging from 22 to 32.8 m/s. Then, the best configuration was proposed for the open low wind speed studies, with the rope brake tests set up for variation of tip speed ratio, TSR and torque measurement. The analytical proof was provided to measure the performance of wind turbine. It was found that the use of four NESP bladed with NRH increased the self-starting speed for all low wind speed tests; 3, 4, 5 and 6 m/s. The lower self-starting wind speed of 5 m/s has the maximum Power Coefficient, Cp=0.1, whereas the current SWT geometry of H/D=0.227 which was originally fixed according to past studies requires further improvement. The higher the rotor height, the higher the Cp of combination of 4 bladed NESP SWT and quarter cylindrical rotor house.

4:45 *Estimating Biomass Sources for a 10 MW Dendro Power Plant Using Leucaena Leucocephala Fuel Wood*

Mohd Izhwan Muhamad and Mohd Amran Mohd Radzi (Universiti Putra Malaysia, Malaysia); Hashim b. Hizam (UPM, Malaysia); Ts. Ir. Mohammad Lutfi Othman (Universiti Putra Malaysia & Advanced Lightning, Power and Energy Research (ALPER), Malaysia); Chandima Gomes (University of the Witwatersrand, South Africa); Mohamad Azani Alias (University Putra Malaysia, Malaysia)

This paper presents the results of an investigation to determine the potential of Leucaena leucocephala as a commercial energy crop for dendro-power generation plants. Dendro-power generation is the generation of electricity from wood fuels. Modern technology enables the efficient, clean and long-term use of wood in Dendro power plants. Various tests and calculations have been carried out, such as moisture content, physical analysis and calorific value of tree species. The Leucaena leucocephala yield per unit area of the special plantation for the development of 10 MW Dendro power plants was estimated. The development of a 10 MW Dendro power plant provides for an annual electricity generation of 50 GWh, which can be used for self-consumption or sold to a power company. This study provides a quantitative approach to estimating the wood requirements for Dendro-power generation which has not been done before. The implementation of this project will also help the economic development of local communities, especially in rural areas.