



World Renewable Energy Congress

MU Murdoch University

# WREC2026

2030 Horizon: The Path to Net Zero Emissions with Renewable Energy

Western Australia  
8 – 11 February 2026

# BOOK OF ABSTRACTS

*Listed in alphabetical order by paper title*

*As of 7 February 2026*

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## A better model for nonlinear wave loads on monopiles supporting offshore wind turbines

Mr Qinming Wu<sup>1,2</sup>, Dr Jana Orszaghova<sup>1,2</sup>, Dr Hugh Wolgamot<sup>1</sup>, Dr Adi Kurniawan<sup>1</sup>, Emeritus Professor H Taylor P<sup>1</sup>, Dr Guy McCauley<sup>1</sup>

<sup>1</sup>The University of Western Australia, Perth, Australia, <sup>2</sup>Blue Economy Cooperative Research Centre, Launceston, Australia

### **Biography:**

*Qinming is currently a PhD student at the University of Western Australia. His PhD research project focuses on nonlinear wave-induced loads on monopiles supporting offshore wind turbines.*

### Introduction

Offshore wind can play an important role in Australia's shift to renewable energy given the country's abundant resources. Six offshore wind zones have been declared, some in relatively shallow waters where monopiles could be used. Monopiles, which are large-diameter tubular steel piles driven into the seabed, support the tower and turbine, rotor-induced forces, and environmental loads from wind, currents, and waves. This research focuses on wave-induced loads. Australia's wave environment differs from the North Sea, where many monopiles are deployed. The southern coast of Australia has persistent longer-period swell waves from the Southern Ocean, whereas the North Sea exhibits larger extreme wave heights and stronger seasonal variability. Nonlinear wave loading, affecting both ultimate limit loads and fatigue, is important in both regions. We find that the often used Morison equation with linear or 2nd order wave kinematics is inadequate and offer a better model for wave loads on monopiles.

### Methodology

The Transformed-FNV (T-FNV) model, a fully nonlinear formulation expressed solely in terms of free-surface motion of the wave field, is a new approach developed at UWA for predicting horizontal wave forces and moments on a vertical surface-piercing cylinder. To validate T-FNV under Australian conditions, wave flume experiments were conducted. Waves ranged from weakly nonlinear to near breaking, with two peak periods (11 and 14 s full scale). Phase-controlled focused wave groups enabled clean extraction of harmonic components of both undisturbed free-surface elevations and loads.

### Results and discussion

T-FNV matches well with measurements for the all the force harmonics (zeroth, 1st (linear), 2nd and 4th, 5th), except for some over-prediction at 3rd due to additional physics there. Nevertheless, the total wave loads were well predicted, making this model a robust and efficient tool.

### Conclusion

The T-FNV model, requiring only free-surface quantities as inputs, is both accurate and computationally efficient. Validated for long-period waves across a range of steepness, it shows good agreement with measurements and is appropriate for storm conditions in Australian waters. Further investigation is underway for shorter period waves, important for fatigue, to fully validate this novel nonlinear model.

## A computational sensitivity study of solar-driven conical desalination system for affordable water solutions

Mr Nandan kumar<sup>1</sup>, Dr. Harender Sinhmar<sup>1</sup>, Dr. DeshBandhu Singh<sup>2</sup>, Dr. Abhishek Saxena<sup>3</sup>, Dr. Sumit Tiwari<sup>4</sup>

<sup>1</sup>Department of Mechanical Engineering, Shiv Nadar Institution of eminence (Deemed to university), NH - 91, Gautam Buddha Nagar, India, <sup>2</sup>Mechanical engineering Department, Graphic Era University (Deemed to be university), Dehradun, India, <sup>3</sup>Mechanical engineering Department, School of Engineering, Dev Bhoomi Uttarakhand University, Dehradun, India, <sup>4</sup>Department of Mechanical Engineering, Motilal Nehru National Institute of Technology, Prayagraj, India

### **Biography:**

*Nandan Kumar is a research scholar specializing in thermal desalination systems. He has completed Master of*

*Technology degree in Thermal Engineering, and his current research focuses on solar thermal desalination system and PVT-CPC (Photovoltaic Thermal-Compound Parabolic Concentrator) modelling.*

In many rural and arid regions, freshwater scarcity remains a critical issue due to inadequate infrastructure and the high cost of conventional purification methods. This study investigates a low-cost solar desalination system by performing a sensitivity analysis on a conical solar still integrated with flat plate collectors (FPCs) and a compound parabolic concentrator (CPC). A detailed thermal model is developed in MATLAB (R2025a) to simulate the system's performance for New Delhi's climatic conditions during the high-solar month of May. The study examines the impact of key design and operational parameters mass flow rate ( $\dot{m}$ ), number of collectors (N), concentration ratio (CR), water depth (WD), and angle of inclination ( $\theta$ ) on freshwater yield and energy output. The system achieved optimal performance at a flow rate of 0.04 kg/s with four FPCs. Sensitivity analysis showed that the angle of inclination ( $\theta$ ) had the highest influence on distillate yield, with the most significant performance change observed in solar radiation absorption and condensation behavior. Meanwhile, the number of collectors (N) emerged as the most influential parameter for exergy efficiency, as it directly governs the amount of thermal energy captured and utilized. Specifically, variations in the number of collectors resulted in a maximum yield change of 47%, with average sensitivity indices of 0.47 for freshwater output and 0.43 for energy efficiency, highlighting its critical role in overall system performance.

These findings highlight the critical role of design and operating parameters in enhancing the performance of the distillation unit, enabling precise thermal optimization and reduced material costs. The proposed system is particularly suited for low-cost, decentralized water purification in off-grid rural communities. It can also support 24-hour operation through thermal storage and effective daytime solar energy utilization, making it ideal for regions with limited access to clean water.

## A Multidimensional Assessment of Europe's Energy Transition and Its Implications for Energy Security

Mr Danial Esfandiary Abdolmaleki, Professor (Associate) Pastora María Bello Bugallo

<sup>1</sup>TECH-NASE Research Group, Department of Chemical Engineering Universidade de Santiago de Compostela, Campus Vida, 15782 Santiago de Compostela, Spain, santiago de compostela, Spain

### *Biography:*

*I am Danial Esfandiary Abdolmaleki, a PhD candidate at the University of Santiago de Compostela, Spain. My research focuses on energy economics, renewable energy systems, and energy security using quantitative and policy-oriented approaches.*

The ongoing transition toward renewable energy in Europe has profound implications for the continent's energy security and broader socio-economic landscape. This study investigates the multifaceted dynamics of energy transition, emphasizing the interplay between renewable deployment, energy dependency, environmental performance, and associated economic factors. Despite extensive research on renewable energy adoption and its environmental benefits, there remains a gap in understanding how these shifts collectively influence energy security.

The model is designed to account for structural heterogeneity among countries, temporal dynamics, and interdependencies among explanatory factors, thereby aligning with best practices in quantitative energy policy research. Furthermore, the analytical framework allows for the examination of potential mechanistic channels through which the deployment of renewable energy and shifts in energy sourcing may indirectly affect energy security outcomes, while controlling for confounding socio-economic characteristics.

Building on this foundation, the second part of the study expands the discussion by positioning Europe's energy transition as a critical turning point for long-term system resilience. The analysis offers an integrative perspective that helps identify structural vulnerabilities—most notably those related to external energy dependence and uneven progress in renewable development—while also highlighting the opportunities arising from accelerated decarbonization efforts. By mapping these dynamics within a harmonized empirical structure, the research provides a clearer understanding of how ongoing shifts in the energy mix shape the robustness, adaptability, and strategic exposure of European energy systems.

The study offers practical value for policymakers and energy planners by delineating where transition strategies may strengthen or weaken energy security under different contextual conditions. The conceptual and empirical insights developed here can serve as a basis for designing targeted policy interventions, optimizing investment decisions, and prioritizing areas where system-level vulnerabilities persist. Moreover, by establishing a multidimensional analytical framework applicable across different European settings, the study enables future researchers to extend the approach to broader temporal horizons or additional structural determinants as the continent's energy landscape evolves.

Ultimately, this research situates Europe's renewable-driven transition within a broader security narrative, emphasizing how coordinated policy action, technological advancement, and structural rebalancing can collectively contribute to more resilient, sustainable, and strategically autonomous energy systems.

## A Photovoltaic cooker with a latent heat storage unit

Prof Ole Jorgen Nydal<sup>1</sup>, Dr. Peter Mashingo<sup>2</sup>

<sup>1</sup>Norwegian University of Science and Technology, Trondheim, Norway, <sup>2</sup>Arusha Technical College, Arusha, Tanzania

### **Biography:**

*Professor Ole Jørgen Nydal has a background in physics and fluid mechanics. A focal area the last 15 years has been on small scale renewable energy technology in collaboration with a group of African universities. A particular challenge has been on solar energy with heat storage methods for cooking.*

### Introduction

Charcoal and fire-wood is the dominating energy source for cooking in both the urban and rural African environments. One reason why the long established direct solar cooking technology has not found widespread use is that cooking can only be made during direct sunshine. Electrical cookers can be alternative solutions for grid connected communities and LPG cookers can be another option if LPG infrastructure exists. Both options need to be economically competitive options.

### Methodology

A technical solution for using Photovoltaic panels (PV) for cooking is presented here. PV can be attractive options provided energy storage methods are included. The reasons for including an energy storage is firstly to allow for cooking during off-sun periods but also to provide a way of converting a low-power PV energy source to a high-power cooking method. The low power from a single PV panel may not be practical for direct cooking purposes, but power from a single PV panel can accumulate energy into a high temperature heat storage, which can then be used for efficiently cooking.

A heat storage unit has been constructed, with heating elements in a top plate and conducting fins into a Solar Salt nitrate mixture. A Tristar charge controller is operated in diversion mode together with a small 12 Volt electrical battery and the heat storage. The heat storage can be charged with excess energy from the PV system; when the electrical battery is full the PV power can be directed to a heat storage.

### Results and discussions

The design of the small scale heat storage unit with a Phase Change Material (PCM) is presented together with test results. The PCM storage with a melt temperature of 220 degrees C is in particular useful for cooking food items which require long cooking times (e.g. beans).

### Conclusion

The results show that alternatives to LPG and grid power for cooking without wood-fuel can be feasible. Even a small PV panel can during the day accumulate high temperature energy for off-sun cooking when needed. The technology is simple and can be further developed and implemented based on local resources.

## A Platform for Long-Term Renewable Energy Planning in South West Interconnected System of Western Australia

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<sup>1</sup>Murdoch University, Perth, Australia, <sup>2</sup>APD Global, Perth, Australia

### **Biography:**

*A. Safaei is currently pursuing a PhD with the Department of Engineering and Energy at Murdoch University, Australia. He received his MSc in Electrical Engineering from Amirkabir University of Technology (Tehran Polytechnic), Iran, in 2012. His research interests include renewable energy integration, power system dynamics, and power system analysis.*

### **Introduction**

The global transition to renewable energy is accelerating, driven by the widespread adoption of renewable energy sources (RES). This transition is crucial for mitigating climate change. In Western Australia, the South West Interconnected System (SWIS) serves over 1.1 million customers but is facing increasing electricity consumption. To address these challenges, substantial investments in RES are necessary to ensure a sustainable energy supply. As RES penetration grows, optimal long-term planning becomes vital to balancing system reliability, minimising costs, and maximising returns for investors. The objective of this study is to develop a platform for long-term optimal planning that supports high levels of RES integration.

### **Methodology**

This research introduces a platform for long-term RES integration in the North Country zone of the SWIS, using PLEXOS software. The study spans a ten-year planning horizon, from 2025 to 2035, incorporating both current and projected generation data from a diverse set of power sources. Additionally, the model integrates load demand data for the entire period, reflecting both current consumption patterns and anticipated future trends. The long-term planning problem is formulated as a Mixed-Integer Linear Programming (MILP) model, with the objective of minimising the total system cost. Real-world Australian Energy Market Operator (AEMO) network constraints are incorporated to reflect practical network limitations, ensuring that the model accurately represents operational conditions.

### **Results and Discussion**

Preliminary results indicate that additional RES will be required to meet the projected electricity demand. Furthermore, the model emphasises the importance of considering network constraints when planning for high levels of RES integration in the SWIS. The platform provides valuable insights into investment opportunities and cost-effective strategies for RES developers. Its ability to evaluate different scenarios and identify the most economically viable solutions offers a distinct advantage for investors.

### **Conclusion**

This study significantly enhances the understanding of long-term RES planning in the SWIS by introducing a platform that optimises energy production and consumption over a ten-year horizon. The platform provides actionable recommendations for maximising the integration of RES while minimising system costs. The findings offer practical insights for investors seeking to optimise their investments in renewable energy.

## A research framework for future product development - ActiVer, a novel prefabricated BIPV system

Prof Dariusz Heim<sup>1</sup>, Prof Tiberiu Catalina<sup>2,3</sup>, Dariusz Czarny<sup>4</sup>, Iosif Ilies<sup>2</sup>, Dr Simo Ilomets<sup>5</sup>, Prof Targo Kalamees<sup>5</sup>, Dr Dominika Knera<sup>1</sup>, Dr Martin Talvik<sup>5</sup>, Dr Anna Wieprzkowicz<sup>1</sup>

<sup>1</sup>Lodz University of Technology, Lodz, Poland, <sup>2</sup>Technical University of Civil Engineering, Bucharest, Romania, <sup>3</sup>National Institute for Research-Development in Construction, Urbanism and Sustainable Territorial Development, Bucharest, Romania, <sup>4</sup>Sto Sp. z o. o., Warsaw, Poland, <sup>5</sup>Tallinn University of Technology, Tallinn, Estonia

### **Biography:**

*Prof. Dariusz Heim, full professor at Lodz University of Technology, Poland. He performs research in the areas of heat and mass transfer, energy systems, building simulation, daylighting, renewable energy, and bioclimatic architecture. He has authored or co-authored more than 250 conference and journal papers.*

### Introduction

There is still an increasing interest in easily adaptable building-integrated photovoltaics (BIPV), which can supply the whole building or individual apartments. The idea of making BIPV more common, cheaper, and easier to install and maintain is still a research and development opportunity. The paper describes the conceptualisation of a new façade-integrated photovoltaic system.

### Methodology

The paper provides an overview of existing building-integrated photovoltaic solutions as a reference point for developing a new system. Then it discusses technical constraints, including durability, maintenance, and service life, to guide the selection of system components such as boards, frames, PV panels, cables, connectors, and binders. The hygrothermal performance was assessed based on two essential criteria influencing the operation and durability of the PV system: the risk of overheating and the risk of condensation. These analyses require laboratory measurements of material properties, and the obtained results will enable an assessment of electrical efficiency under real-world operating conditions. Additionally, factors such as aesthetics, adaptability, and cost-effectiveness will determine the ultimate concept of this technology for further development.

### Results and Discussion

The authors propose a method for developing ActiVer system for smart building envelopes. In this study, we developed the initial concept of system construction, consisting of two main boards: i) the first, which is the back side, permanently connected with the construction of the external wall, and ii) the second, which consists of single panels easily replaceable for maintenance. Both boards are made from the natural, lightweight and environmentally friendly perlite-based raw material. The unique technical features include being largely prefabricated, self-supporting, compatible with different external walls construction, and easy to maintain. Moreover, based on the main project assumptions, the system is characterised by guaranteed hygrothermal performance, a low carbon footprint, and reusability.

### Conclusion

The proposed PV system is based on the custom-made, semi-flexible PV modules equipped with monocrystalline back-contact cells. All technical details in a graphical form, including electrical connections and mechanical joints of the boards, are also presented. The research and development study is conducted in cooperation with the industrial partner.

## A Systematic Literature Review of the Indonesia New Capital City for Electricity Market Transformation

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<sup>1</sup>Intelligent Power Energy System (InPES) Research Group, Research Center for Electrical Technology, Research Organization of Energy and Manufacture, National Research and Innovation Agency (BRIN), South Tangerang, Indonesia, <sup>2</sup>Research Center for Energy Conversion Technology, Research Organization of Energy and Manufacture, National Research and Innovation Agency (BRIN), South Tangerang, Indonesia, <sup>3</sup>Mining Engineering Department, McGill University, Montréal, Canada, <sup>4</sup>Directorate of Green Transformation, Deputy for Green and Digital Transformation, Capital City of Nusantara, Indonesia

### **Biography:**

*Abdul is an Indonesian researcher with 15 years of experience in energy and power systems, specializing in infrastructure design, planning, and operation modeling. He leads bottom-up approaches to accelerate net-zero emissions, focusing on readiness and impact for developing nations at regional and national scales.*

Nusantara, Indonesia's planned new capital, is mandated to achieve net-zero emissions with a dominant share of electricity from clean, green, and low-emission (CGLE) sources by 2045—fifteen years ahead of the national target. This greenfield development offers a rare opportunity to design an electricity system free from many of the legacy constraints of existing centralized grids, enabling integration of smart-city infrastructure and piloting of market mechanisms that could catalyze a nationwide shift toward decentralization. This study conducts a systematic literature review (SLR) to synthesize global and domestic evidence on electricity market transformation pathways relevant to Nusantara's context. Following PRISMA 2020 guidelines, 142 peer-reviewed articles, policy documents, and technical reports published between 2010 and 2025 were screened, with 58 meeting inclusion criteria. The findings are organized into four thematic domains: (i) market structures and regulatory models – comparative analyses of centralized, liberalized, and hybrid markets, highlighting limitations of Indonesia's current single-buyer model under the state-owned utility. (ii) distributed energy resource (DER) integration – technical and economic frameworks for incorporating rooftop solar, battery energy storage systems, electric vehicles, and demand response into the designated Nusantara urban grids. (iii) enabling technologies and digitalization – applications of virtual power plants (VPPs), advanced metering infrastructure, and artificial intelligent (AI)-driven optimization for grid flexibility. (iv) policy and investment mechanisms – incentive structures, ancillary service markets, and regulatory sandboxes that have accelerated transformation in comparable jurisdictions. The review reveals a persistent misalignment between Indonesia's regulatory framework – most notably the abolition of rooftop solar net-metering – and the decentralized, prosumer-driven models needed for high DER penetration. Inherently, the global evidence shows that VPP-enabled aggregation, combined with dynamic pricing and ancillary service remuneration, can reduce peak demand, defer costly infrastructure expansion, and enhance CGLE's sources integration. For Nusantara, targeted reforms are essential: establishing a dedicated VPP regulatory sandbox, reinstating or redesigning prosumer incentives, and standardizing data and communication protocols to ensure interoperability. By integrating global best practices with Indonesia's policy realities, this review offers a roadmap for aligning market design, technology deployment, and regulatory innovation to achieve Nusantara's 2045 sustainability goals and advance the broader national energy transition.

## Advanced Single phase PLL for Power Electronics Inverters: renewable and non-renewable Distributed Generators

Dr Mohammad Bany Issa<sup>1,2</sup>, Dr Pastora María Bello Bugallo<sup>1</sup>

<sup>1</sup>TECH-NASE RESEARCH GROUP, UNIVERSITY OF SANTIAGO DE COMPOSTELA, CAMPUS VIDA, , Spain,

<sup>2</sup>DEPARTMENT OF RENEWABLE ENERGIES, FACULTY OF ENGINEERING AND TECHNOLOGY, PHILADELPHIA UNIVERSITY, , Jordan

Power Electronics Converters (PECs) are one of the most important technologies for converting power types. Normally, to convert DC power into AC, several types of inverters are used. Distributed Generators (DGs), including both renewable and non-renewable DGs, can be integrated into the grid through PECs. For this integration, the grid variables should be considered. Phase-Locked Loops (PLLs) are the most common synchronization technique used for integrating the DG into the grid. This chapter aims to analyze advanced PLL techniques that can generate an estimated phase angle to control the output power from the DGs and integrate it with the grid. The estimated phase angle could be an inverter's input to generate a reference voltage for shaping the output power. The proposed PLLs is created by building the real-time diagram, the mathematical representations, the linear model, PI controller gains, and testing these techniques via the MATLAB/Simulink tool. The results show that the advanced PLLs can synchronize the electrical grid in a short time and remove the DC-offset effect in the input of the PLL. The proposed PLLs will be promising technologies in real applications due to their fast response, the ability to remove the DC offset, simplicity, and robustness.

## Advancing Energy and Educational Equity in a Last-Mile Andean Community

Dr Shashi Persaud<sup>1</sup>

<sup>1</sup>Southern Alberta Institute of Technology, Calgary, Canada

### **Biography:**

*Dr. Shashi Persaud is an instructor at Southern Alberta Institute of Technology, specializing in grid operations and renewable integration. He partners with Light Up the World (LUTW) to lead volunteer solar initiatives in Andean Peru, advancing energy equity through off-grid solutions that combine engineering, education, and sustainable development.*

As the world grapples with growing energy consumption and its effects on the climate, many remote communities remain excluded from even basic energy access. Their reliance on polluting fuels and disposable batteries undermines household health, income, and environmental sustainability. This 2025 case study showcases a volunteer-powered initiative in a last-mile village, high in the Peruvian Andes. Student and faculty volunteers from two Alberta Institutes of Technology partnered with the Light Up the World (LUTW) foundation and donors to design, procure, and install an off-grid solar photovoltaic (PV) plus internet system to support the local school and broader community. The project aimed to advance energy and education equity while providing meaningful volunteer experience.

Prior to deployment, volunteers completed structured training in system design and installation procedures. Led by LUTW experts, these sessions equipped participants with the technical competencies required for effective fieldwork. During the subsequent week-long winter deployment, volunteers traversed rugged terrain to reach the remote site. Living and working onsite, the team installed, commissioned, and delivered: (i) a 6.66 kW PV system with 15 kWh battery storage; (ii) a satellite-based internet service; (iii) an equipped computer lab; and (iv) a three-phase distribution system powering outlets and LED lighting across approximately 40 working spaces in a dozen buildings of varied construction and states. Integrated online performance monitoring ensures long-term oversight and support.

The system now powers and connects the school, enabling brighter classrooms, longer learning hours, and access to digital resources. Teachers began integrating technology while receiving online training to build fluency. Community members receive internet vouchers to use or sell, creating new opportunities for connectivity and modest income. A preliminary post-trip performance analysis confirmed stable power delivery and consistent internet uptime, validating the system's real-world effectiveness. Qualitative post-trip surveys revealed deep volunteer appreciation for the hands-on experience and service impact.

This initiative showcases a replicable and recommended model grounded in experiential learning, inclusive technology, charitable action, and volunteer collaboration. Despite significant challenges, the project demonstrates how a purpose-driven organization, supported by academic and industry partners, can illuminate the path toward a just, inclusive, and sustainable future for underserved communities.

# Advancing Proton-Exchange Membrane PEM: A Comparative study of Eco-friendly and Cost-effective alternatives and their properties

Mr Chigbo Oqualili<sup>1</sup>

<sup>1</sup>University Of Yamanashi, Japan, Kofu, Japan

## **Biography:**

*OGUALILI Chigbo Hypolite, Doctoral Student at University of Yamanashi, Japan, specializing on Proton Exchange Membrane development for fuelcells, under the supervision of Prof Kenji Miyatake. Working as Assistant Chief Scientific Officer at Energy Commission of Nigeria.*

*Worked on Installations and Maintenance of Hybrid Renewable Energy Systems, Energy Auditing, Efficiency, Conservation.*

## Introduction

Hydrogen fuel cells (HFCs) are electrochemical devices that convert the chemical energy of hydrogen and oxygen into electricity, with water and heat as the only byproducts. They offer a clean and efficient alternative to fossil fuel-based energy systems, making them a promising technology for sustainable energy solutions. Proton Exchange Membranes (PEMs) are central to the performance of hydrogen fuel cells. They allow protons to pass from the anode to the cathode while blocking electrons and gases. The most widely used PEM is Nafion, a sulfonated tetrafluoroethylene-based fluoropolymer-copolymer developed by DuPont (2-4). Nafion exhibits excellent proton conductivity and chemical stability but is expensive and environmentally persistent. Limitations of Nafion are, but not limited to high cost due to complex synthesis, decreased performance at high temperatures (>80°C) and environmental concerns due to fluorinated compounds. SPP-TP-f refers to a specific type of sulfonated polyphenylene (SPP) polymer that contains tetrafluorophenylene units. It is designed for use as a Proton Exchange Membrane (PEM) in hydrogen fuel cells, particularly under high-temperature and low-humidity conditions. The Advantages over Nafion are, and not limited to: Low Fluorine Content, High Proton Conductivity, Thermal and Chemical Stability, Improved Solubility, Mechanical Reinforcement:

Challenge is that the cost of Ni(COD)<sub>2</sub>, or bis(1,5-cyclooctadiene) nickel(0) used as Catalyst in the polymerization process is very expensive.

## RESEARCH OBJECTIVES

The objective of this research is to synthesize a reinforced membrane with unique abilities of higher durability, longevity, performance stability, high power density and cost efficiency, for the next generation fuel cells.

## METHODOLOGY

Synthesis of SPP-TP-f Polymer (Equation of Reaction)

## Results

GPC profile of SPP-TP-f 5.1

## COMPARING THE MECHANICAL PROPERTIES MEASUREMENT OF THE SPP-TP-f 5.1 MEMBRANE, FOR THE REINFORCED AND THE PRSTINE UNREINFORCED

### Conclusions

The above results show that SPP-TP-f Polymer can be produced with cheaper Catalyst of NiBr<sub>2</sub>, without using using Ni(COD)<sub>2</sub>, which is a highly expensive catalyst, thereby reducing the cost of the production, also reducing the amount of Fluorine in the environment.

## An Effectiveness Number of-Transfer-Units Model for the Discharge Cycle of an Ice-on-Coil Thermal Storage Tank

Mr Lebohang Alex Nthama<sup>1</sup>, Mr Joseph Eminsang Conduah<sup>1</sup>, Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>, Professor Kanzumba Kusakana<sup>1</sup>

<sup>1</sup>Central University Of Technology, Free State, South Africa, Bloemfontein, South Africa

### **Biography:**

*Joseph Eminsang Conduah, Lecturer and Doctoral Student, and Professor Kanzumba Kusakana, Head of Department, are with Electrical, Electronic & Computer Engineering, Central University of Technology, Free State, South Africa. Lebohang Alex Nthama, Postgraduate Student, and Dr. Olumuyiwa Yinus Odufuwa, Senior Lecturer, are with Mechanical & Mechatronic Engineering, same university.*

Ice Thermal Energy Storage (ITES) is a reliable method for peak cooling demand and operational cost reduction. This paper introduces a simplified but robust analytical model to forecast the discharge capacity of an ice-on-coil thermal storage tank. The model applies the Effectiveness-Number of Transfer Units ( $\epsilon$ -NTU) approach utilized in symmetric regenerators, where the energy-storing matrix is ice. These governing equations are invoked in Engineering Equation Solver (EES) with the inputs of tank geometry, ice thickness, and fluid flow rate. The model delivers the number of transfer units (NTU), capacitance ratio, and resulting effectiveness, which is the outlet fluid temperature profile with time. Close accord with published experimental data on validation indicates that it is close. Year-around analysis is conducted on hour-by-hour temperatures; it indicates the system proposed saves more than 40% of peak summertime cooling electricity demand and achieves a payback period of less than 4 years for demand charge savings. Environmental analysis also depicts an annual reduction of approximately 15 tons of CO<sub>2</sub> emission from diverted energy use to off-peaking hours. This study is a useful and rapid aid for engineers to use in first sizing and approximating the performance of ice storage systems based on a standard heat exchanger model.

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<sup>1</sup>Central University of Technology, Freestate, South Africa, Bloemfontein, South Africa

### **Biography:**

*Joseph Eminsang Conduah, Lecturer and Doctoral Student, and Professor Kanzumba Kusakana, Head of Department, are with Electrical, Electronic & Computer Engineering, Central University of Technology, Free State, South Africa. Lebohng Alex Nthama, Postgraduate Student, and Dr. Olumuyiwa Yinus Odufuwa, Senior Lecturer, are with Mechanical & Mechatronic Engineering, the same university.*

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## Artificial Neural Network-Based Predictive Modeling of Solar-Assisted Microbrewery Cooling Systems with Economic Analysis

Mr Joseph Eminsang Conduah<sup>1</sup>, Professor Kanzumba Kusakana<sup>1</sup>, Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>

<sup>1</sup>Central University Of Technology, Free State, South Africa, Bloemfontein, South Africa

### **Biography:**

*Joseph Eminsang Conduah is a lecturer and doctoral student in Electrical, Electronic and Computer Engineering at the Central University of Technology, Free State, South Africa. Kanzumba Kusakana is a professor and head of the same department, while Olumuyiwa Yinus Odufuwa is a senior lecturer in Mechanical and Mechatronic Engineering.*

Microbreweries are experiencing mounting pressure to decrease energy use and costs of operation at the cost of reduced product quality. The research presents a new system involving the combination of photovoltaic (PV) power systems and low-energy cooling in microbreweries optimized by artificial neural network (ANN) modeling for predictive performance analysis. Solar PV supplies power for the pump auxiliary cooling system loads to reduce grid reliance. System efficiency, energy utilization, and cooling load are forecast by a feedforward ANN that is trained on simulated and available open dataset using MATLAB's nnstart toolbox. Economic assessment is performed with the Net Present Value (NPV) and Discounted Payback Period (DPP) indicators. Results show that ANN models are able to predict cooling performance accurately under different solar irradiance and brewery load conditions with possible energy saving rates of up to 30% and payback time less than 6 years. This work adds a scalable, smart, resource-conscious energy optimization solution for small breweries.

## Aspects of Wind Turbine: Modeling Avian Collision Risk and Latent Degradation of Components

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<sup>1</sup>Murdoch University, Perth, Australia

### **Biography:**

*I am a statistician and applied mathematical researcher specializing in system degradation, lifetime assessment, and maintenance optimization of complex systems such as wind turbines. My work bridges academia and industry. Recently, I have been modeling bird collision risks in wind farms using stochastic processes to support environmentally sustainable energy.*

Renewable energy plays a vital role in reducing global carbon emissions and driving the transition to a sustainable energy future. Wind energy, in particular, offers significant potential but also presents challenges related to environmental impact and system reliability.

This research addresses two critical aspects of wind turbine sustainability: environmental impact and operational reliability. First, we propose a stochastic modeling framework to assess bird-turbine collision risk by simulating avian flight paths using Wiener and Ornstein-Uhlenbeck processes. The model differentiates between migratory and resident bird behaviors, incorporating flight speed, hub height, and environmental factors such as thermal lift to estimate collision probabilities under varying turbine configurations.

Secondly, we develop a maintenance policy for hard-to-access turbine components based on the Remaining Useful Lifetime (RUL) framework. The degradation process is modeled as a two-dimensional continuous-time stochastic system with a latent degradation level and a correlated observable marker. An adaptive inspection policy estimates degradation levels using marker observations and adjusts maintenance timing accordingly. Numerical results show improved predictive accuracy and cost-efficiency over fixed inspection schedules, even with weak marker-degradation correlation.

By addressing both ecological and engineering challenges, this research supports the deployment of wind energy systems that are not only more environmentally responsible but also economically sustainable. The outcomes contribute to better turbine siting, enhanced asset management, and ultimately a more resilient and wildlife-conscious renewable energy sector.

## Assessment of regional and national biomass potential for decarbonising the industry sector in Indonesia

Mrs Sari Khairudin<sup>1</sup>, Mr Sunil Herat<sup>1</sup>, Mr Widodo Purwanto<sup>2</sup>, Mr Prasad Kaparaju<sup>1</sup>

<sup>1</sup>Engineering and built environment, Griffith University, Brisbane, Australia, <sup>2</sup>Department of Chemical Engineering, Faculty of Engineering, University of Indonesia, Depok, Indonesia

### **Biography:**

*Sari Khairudin is a higher-degree research student at the School of Engineering and Built Environment, Griffith University. She has 15 years of experience in bioenergy, renewable energy, and energy efficiency policymaking at the Ministry of Energy and Mineral Resources, Republic of Indonesia.*

Indonesia has committed to achieving net-zero emissions from the energy sector by 2060. The industry sector, one of the most difficult sectors to decarbonize, has consistently consumed the largest share of final energy, reaching 3,585 PJ, or 45.94% of total energy use, in 2024. In the same year, biomass contributed 325 PJ to the industrial energy supply. Biomass offers a significant opportunity to reduce carbon emissions and substitute fossil fuels, particularly in hard-to-abate sectors such as heating.

This paper assesses Indonesia's regional and national theoretical biomass energy potential using a statistical approach for the current year, 2025, and forecasts to 2060. A total of 35 biomass resources were examined, grouped into primary forest residues, secondary forest residues, agricultural field residues, agricultural process residues, and organic waste. Only resources with a conversion technology readiness level (TRL) of 7 or higher were considered. The methodology focuses on biomass as primary energy, employing a bottom-up approach based on land cultivation area, crop productivity, crop production, residue-to-product ratio, availability-to-energy fraction, collection efficiency, and heating value.

Three scenarios—low, moderate, and advanced—were applied, differentiated by biomass group coverage, crop productivity, collection efficiency, and additional land cultivation after accounting for competing uses. Results show that Indonesia's current biomass potential is 2,351 PJ, rising by 2060 to 2,956 PJ (low), 3,802 PJ (moderate), and 6,040 PJ (advanced), against a projected industrial demand of 6,615 PJ. Palm oil residues provide the largest contribution, accounting for 73% in the low scenario. Regionally, Riau province in Sumatra has the highest biomass potential, while industrial demand is greatest in Java. This paper recommends developing bio-hubs as supply chain infrastructure and ensuring sustainability by integrating agriculture, forestry, and waste streams in the upstream with energy production downstream.

## Australia's high potential in producing Green Hydrogen to make it an export product

A/Prof Ahmad Zahedi<sup>1</sup>

<sup>1</sup>James Cook University, Townsville, Australia

### **Biography:**

*Associate Professor Ahmad Zahedi is a Principal Research Fellow, with James Cook University. Educated in Iran and Germany, over 30-years' teaching and Research in Renewable Energy at university level in Australia, Japan, Europe, completed 15 industry-funded projects, more than 200 publications, including 4 books, trained 21 successfully completed PhD candidates.*

Green hydrogen (H<sub>2</sub>) is a clean energy carrier, able to de-carbonize many industries, such as steel, chemicals, transport, shipping, aviation, and power systems. Another important role of Green H<sub>2</sub> is to be integrated into the renewable energy power systems to store excess solar energy and wind power as Green H<sub>2</sub> for being used later.

The European Union (EU), the United States, and China are rapidly pursuing Green H<sub>2</sub> production. The EU is advancing Green H<sub>2</sub> production with the capacity of more than 20 GW to reduce their dependency on Russian gas.

The Chinese Kuqa Green H<sub>2</sub> Plant in Xinjiang is the world's largest project, and fully operational since 2023. This plant has the capacity of 260 MW Alkaline electrolyzer and produces up to 20,000 tons of H<sub>2</sub> per year to be used for national use and exporting overseas. Almost 90% of the electricity required by the electrolyzer is generated by a 300 MW solar PV farm. No battery storage is used; electricity grid is used as a backup.

Australia with the world's best renewable energy resources is set to become a top global green hydrogen producer for its industries and exporting to Asia and the Middle East. However, cost reduction is one of the main challenges to compete with.

The objective of this talk is to present a model developed for Green H<sub>2</sub> production plant suitable for Australia. In many parts of Australia, especially in North Queensland and Northern Territory, a 300 MW solar PV farm can produce more electricity than the 300 MW solar farm in Chines Xinjiang project at much lower cost.

Hence, Australia has high potential of producing large amount of Green H<sub>2</sub> to make it an export product. However, it requires Government, Industry, and Funding Organization to support. The model of Green H<sub>2</sub> production plant presented in this talk can be used in any part of the world.

## Australia's role in the 'Global Stocktake' and to limit global temperature rise to +1.5 °C.

**Prof Sven Teske<sup>1</sup>**

<sup>1</sup>University Of Technology Sydney, Sydney, Australia

### **Biography:**

*Dr Sven Teske is a Professor and Research Director at the Institute for Sustainable Futures, University of Technology Sydney/Australia, focussing on energy decarbonisation pathways for countries, regions, urban environments, and specific industry sectors towards Net-Zero by 2050. He holds a PhD in economics from the University of Flensburg in Germany.*

The presentation consists of two parts: First part provides an overview about the Global stocktake and how the remaining carbon budget, second part focuses on Australia's unique role to provide resources and renewable energy domestically and globally.

### 1. What is the remaining carbon budget?

The G20 brings together the world's major economies. Its members represent 85% of global GDP, 75% of international trade, and two-thirds of the world's population. According to the Intergovernmental Panel on Climate Change, the total remaining global carbon budget required to limit the world's temperature increase to 1.5 °C (with 67% likelihood) is 400 GtCO<sub>2</sub>, decreasing to 50% likelihood if emissions reach 500 GtCO<sub>2</sub> between 2020 and 2050. The UNFCCC's 'Global Stocktake' addresses the distribution of the remaining carbon budget to countries and industry sectors, to assess the technical, financial, and policy measures required for decarbonization and the national and international responsibilities involved. In this paper, the decarbonization pathways for all G20 member countries with high technical resolution, are broken down into key industry sectors. The energy-related national carbon budgets necessary to maintain the remaining global carbon budget between 400 GtCO<sub>2</sub> and 500 GtCO<sub>2</sub> are calculated and a new methodology how a fair distribution can be achieved, considering the historical emissions and economic situations of all G20 countries is presented.

### 2. What is Australia's role in the global energy transition?

The presentation will provide answers to the following research questions:

- a. To what extent can energy-related emissions reductions be accelerated by 2030 and 2035 in Australia—with a view to finding a pathway by which Australia can reduce its emissions overall by 75% by 2030 and to net zero by 2035?
- b. What is the earliest date by which real zero energy-related emissions can be achieved?
- c. What level of emissions reductions is technologically possible by 2030 and 2035 in selected each industry sectors, given the right level of policy support and investment?
- d. To what extent can Australia supply mineral resources for the global energy transition?
- e. To what extent can Australia export renewable energy – either imbedded or directly in form of synthetic fuels.

## Biofuels in Australia: A policy analysis of barriers and pathways for increased uptake

Mrs Ellen Zebege<sup>3</sup>, Tania Urmee<sup>1</sup>, Navid Moheimani<sup>2,3,4</sup>, Parisa Bahri<sup>5</sup>

<sup>1</sup>School of Engineering and Energy, Murdoch University, , Australia, <sup>2</sup>Centre for Water, Energy and Waste, Murdoch University, , Australia, <sup>3</sup>School of Environmental and Conservation Sciences, Murdoch University, , Australia, <sup>4</sup>Algae R&D Centre, Murdoch University, , Australia, <sup>5</sup>Pro Vice Chancellor, College of Science, Technology, Engineering and Mathematics, Murdoch University, , Australia

*Biography:*

*TBC*

The escalating threat of climate change has intensified the global urgency to invest in renewable fuel sources. Biofuels, unlike fossil fuels, offer a renewable alternative. However, variations in the raw materials, termed “feedstocks,” used for production have significant implications on sustainability. One such feedstock, microalgae (third-generation biofuel), offers notable advantages including high biomass productivity, non-reliance on freshwater or arable land, and the elimination of the “food vs fuel” debate. Despite these advantages, biofuel adoption in Australia remains limited. As of 2024, biofuels account for less than 0.5% of total transport fuel consumption. In comparison, Brazil has achieved a 26% renewable energy share in transport—driven largely by a blending mandate of 27% in gasoline and used as pure fuel. This raises a critical question: “Given the clear advantages of using biofuel, why is the uptake of biofuels in Australia relatively low, and how can the uptake of biofuels be increased?”

To address this, the study adopts a two-phase policy and gap analysis to assess Australia’s policy framework against international benchmarks and strategic objectives. The methodology involves mapping current policy status against strategic objectives to reveal legislative and implementation shortcomings. A systematic approach was utilized to identify relevant policy documentation and grey literature, with source quality and inclusion assessed using established frameworks. Policy features were extracted and mapped using bibliometric tools and qualitative coding to synthesize themes and actor-networks. Australia’s policy environment is then benchmarked against international examples using a SWOT–TOWS approach to translate sector strengths, weaknesses, opportunities, and threats into actionable policy recommendations. Each policy option is evaluated for stability, adequacy, effectiveness, and efficiency. The study ultimately proposes evidence-based strategies—such as introducing blending mandates and strengthening fiscal incentives—to accelerate Australia’s biofuel transition in line with global best practice.

## Carbon Energy Cycle for Sustainable Waste Biomass Management for Value-added Bioenergy and Bioproducts

Prof Jonathan Wong<sup>1</sup>

<sup>1</sup>Research Center for Eco-environmental Engineering, Dongguan University of Technology, Dongguan City, China

**Biography:**

*Jonathan Wong is an Academician of the European Academy of Sciences and Arts, Clarivate Highly Cited Researcher, and top 2% scientist in Stanford University Ranking 2024 with citation > 29017 and H-index 91. He is currently a Top Talent Professor of the Dongguan University of Technology specialized in biowaste valorization.*

Generally, the earth produces 173 billion tons of materials through photosynthesis every year, which contains energy equivalent to 10-20 times the world's total energy consumption, but its current utilization rate is less than 3%. Biomass waste generated from the processing and consumption of the biomass resources is the most abundant renewable resource on earth, which can be converted into various forms of energy, including biofuels, biopolymer, and biogas via biological/chemical approaches. The biomass carbon energy cycle refers to the flow of carbon within biomass as they are used for energy production and then recycled back into the environment. By integrating the biomass carbon energy cycle, we can create a sustainable and regenerative system that manipulate the carbon cycle to produce renewable energy while minimizing environmental impact and achieving circular economy. Overall, the sustainable biowaste management provides several benefits such as mitigation of GHG emissions, improvement of soil quality, reduced waste disposal cost, alternative for fossil-based sources and job creations. However, the efficient management of biowaste should consider the suitable technological approaches based on the availability of resources, local economy and need to cater for the increasing circular economy. In this presentation, innovation bio-valorisation technologies developed including engineering modification of two phase anaerobic digestion design with metabolic manipulation for higher biogas outputs, innovative catalytic conversion of waste biomass for hydrogen production and bioconversion of waste biomass to value added products. An estimate of about 3.5 to 5% reduction of total carbon dioxide emission from China will be achieved by adopting this carbon energy cycle approach.

## Carbonization of Waste Biomass and Applications

教授 Chiu-hsuan Lee<sup>1</sup>, Yue-Hua Tian, Qi-Xuan Li, Prof. Je-Lueng Shie

<sup>1</sup>Chaoyang University Of Technology, Taichung, Taiwan

### **Biography:**

*Chiu-Hsuan Lee is an Assistant Professor at Department of Environmental Engineering and Management, Chaoyang University of Technology, Taichung, Taiwan*

**Introduction-** Rapid economic and population growth has led to large amounts of waste, causing environmental pollution and contributing to climate change. Agricultural and forest biomass wastes are often burned or discarded, resulting in significant resource loss. To address these environmental challenges effectively, surplus and potentially reusable waste should be properly managed to promote resource recycling. This study investigates the feasibility of converting *Avicennia marina* and spent mushroom substrates into high-value products for reuse.

**Methodology-** This study investigates the carbonization applications of two biomass materials, *Avicennia marina* and spent mushroom substrates. The carbonization was conducted at different temperatures (300, 500, and 700 °C) for 1 hour. The characteristics of the carbonized products were analyzed, including proximate analysis, elemental analysis, calorific value measurement, and FT-IR spectroscopy. These analyses were conducted to evaluate the characteristics of both the raw materials and the resulting biochar, as well as to identify the effects and differences brought by the experimental conditions, thereby determining the most suitable operating parameters.

**Results and Discussion-** The characteristic analysis of the raw materials showed that *avicennia marina* contained 19.22% moisture, 54.48% volatile matter, 14.13% ash, and 14.95% fixed carbon. In comparison, the spent mushroom substrate exhibited 36.41% moisture, 68.94% volatile matter, 7.70% ash, and 18.58% fixed carbon.

Elemental analysis revealed that the carbon content of *avicennia marina* decreased by 13.2%, while that of the spent mushroom substrate increased by 21.6% as the temperature increased from 300 °C to 700 °C. FTIR analysis confirmed the presence of functional groups. In *Avicennia marina*, characteristic peaks were observed at C–H stretching, N–H bending, and C–O stretching. In the spent mushroom substrate, peaks corresponding to CO<sub>2</sub> stretching, C=C stretching, and C=O stretching were observed.

**Conclusion-** Finally, the carbonized products of *avicennia marina* and spent mushroom substrate were found to exhibit distinct characteristics under different temperature conditions. Future work will focus on evaluating the application of these biochars for the adsorption of gaseous organic pollutants in order to assess their adsorption performance. The goal is to enhance the potential for waste reutilization and improve economic benefits.

## Challenges and opportunities of rural electrification in Australia and Sub-Saharan Africa

Dr Gloria Odo<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Gloria is a lecturer with a passion to facilitate sustainable implementation and use of energy technologies. She teaches in a variety of topics including engineering sustainability and design. She has been involved in research on smart cities, Distributed Energy Resources, clean cooking, the energy-food nexus and biogas technology.*

### **Introduction**

Many parallels can be drawn from the energy access challenges faced by rural and regional communities in both Australia and Sub-Saharan Africa. Both regions have dispersed populations that are geographically isolated, which are traditionally difficult and expensive to electrify. This paper seeks to synthesise and compare the challenges and opportunities of rural electrification in Australia and Sub-Saharan Africa.

### **Methodology**

Existing literature and case studies are reviewed to identify the key challenges, learnings and opportunities to improve rural electrification in Australia and Sub-Saharan Africa. The PESTLE framework is used to categorise the challenges and opportunities.

### **Results and Discussion**

Rapid deployment of distributed energy systems consisting of solar photovoltaic (PV) systems with batteries are occurring in both regions. Common barriers include limited access to and understanding by communities of information about energy technologies, lack of local skilled workforce to operate and maintain energy technologies, administrative capacity and governance, access to capital to install energy systems and lack of communication and cooperation between different levels of government. Opportunities include leveraging the rise of social enterprises that focus on rural electrification and internet of things (IoT) to assist in remote monitoring of energy technologies.

### **Conclusion**

The paper brings together key learnings from rural electrification in Australia and Sub-Saharan Africa, highlighting opportunities for joint collaborations to improve energy access in both regions.

## Cluster-Based Machine Learning Approach for Pitting Corrosion Analysis in Offshore Renewable Energy Structures

Mr Yadukrishnan Satheesan<sup>1</sup>, Dr Til Baalisampang<sup>1</sup>, Dr Ehsan Arzaghi<sup>2</sup>, Dr Hamid Ahmadi<sup>1</sup>, Professor Vikram Garaniya<sup>3</sup>, Professor Rouzbeh Abbassi<sup>4</sup>

<sup>1</sup>Australian Maritime College, Launceston, Australia, <sup>2</sup>Queensland University of Technology, Brisbane, Australia, <sup>3</sup>RMIT University, Melbourne, Australia, <sup>4</sup>Macquarie University, Sydney, Australia

### **Biography:**

*Yadukrishnan Satheesan is a Doctoral Candidate at the Australian Maritime College, University of Tasmania. His research involves predictive modelling of corrosion fatigue in stainless steels, integrating experiments with machine learning. With a background in subsea engineering, he is committed to improving structural reliability and sustainability in renewable energy systems.*

Stainless steel is widely employed in offshore renewable energy systems, including wind turbine towers, rotor components, and support structures, owing to its favourable combination of corrosion resistance and mechanical strength. However, in aggressive marine environments, localised attack in the form of pitting corrosion remains a critical degradation mechanism that can compromise the integrity of submerged and coastal components. Despite advances in structural monitoring and degradation modelling techniques, the stochastic morphology of pits, characterised by irregular depth, diameter, and density distributions, remains poorly integrated into predictive models, representing a key gap in current corrosion assessment. This study applies cluster-based feature engineering to incorporate pit morphology into machine learning (ML) models, aiming to improve the predictive classification of corrosion-induced damage states that emerge under different exposure conditions.

Eighty-four AISI 316L samples were exposed to ferric chloride solution following ASTM G48 standard for 24, 48, and 72 hours. Pit morphology parameters such as maximum diameter, and depth were quantified using an optical profilometer. Pit damage features (depth, diameter, and metal loss) were transformed into a two-dimensional representation using Principal Component Analysis for clustering. Each sample's distance to the nearest cluster-centroid was introduced as an additional engineered feature. Supervised classifiers were trained and evaluated with and without this feature, using classification accuracy as the performance measure.

Incorporating centroid distance improved the predictive performance across most ML models. The prediction accuracy (R<sup>2</sup>) of Support Vector Classification and Random Forest increased from 79.2% to 87.5% (+8.3%), while K-nearest neighbors improved from 58.3% to 75.0% (+16.7%). Bagging and RUSBoost also exhibited moderate gains in R<sup>2</sup>, whereas AdaBoost remained unchanged and the Decision Tree declined by 8.3%. These results demonstrate that centroid-based features capture scale-independent aspects of pit morphology overlooked by conventional metrics.

Reliance on accelerated exposure classification can be considered limitations in this study. Future research will integrate fatigue life prediction of corroded samples, enabling AI-driven structural health monitoring systems that couple corrosion morphology with mechanical degradation for reliability assessment of offshore wind and marine renewable assets. This study can enhance ML classification of pitting corrosion stages, contributing to the digital transformation of offshore renewable energy systems.

# Comparing Time Series and Machine Learning Tools for Short Term Forecasting For Renewable Energy

Prof John Boland<sup>1</sup>

<sup>1</sup>Adelaide University, Felixstow, Australia

## **Biography:**

*John Boland is Emeritus Professor of Environmental Mathematics and Deputy Director of the Industrial AI Research Centre at Adelaide University. His research covers water resource management to renewable energy utilisation to energy efficient house design and environmental accounting. Stochastic modelling of climate variables is his forte.*

## Introduction

There is a plethora of modelling methods for forecasting weather and renewable energy generation utilising both statistical time series analysis and artificial neural networks. Autoregressive Moving Average (ARMA) and Long Short-Term Memory (LSTM) neural networks are both versatile and easy to train.

## Methodology

In this paper we construct one step ahead forecast models for wind farm output and regional electricity price data using both traditional time series methods and hyper parameter tuned LSTM models and compare their skill and ease of training. Seven years of output from a single wind farm and five years of electricity prices for South Australis at a 30 minute time scale are used. The data was split into training and testing sets for both variables, with the testing set being the last two years in each case.

## Results and Discussion

The results for the two methods, as shown in Table 1, are very similar, with LSTM marginally better for the wind farm and the reverse true for the electricity prices. The ARMA approach is much more parsimonious so can be considered superior from that perspective. More importantly, it has a very simple structure and its physical nature can be easily understood, addressing the need for model explainability.

	Model	NMBE	NMAE	NRMSE
Wind Farm	ARMA	-0.003	0.149	0.229
Wind Farm	LSTM	0.0003	0.143	0.225
Price	ARMA	0.002	0.025	0.220
Price	LSTM	-0.0002	0.027	0.233

Table 1: Error metrics for comparing the two approaches to forecasting

## Conclusion

LSTM and ARMA produce similar results, but ARMA is more parsimonious and explainable. Future work will include examining other machine learning tools to see if there is an improvement for the short-term forecasting. There will also be work on forecasting output from solar farms, which may require a hybrid technique, capturing the seasonality with a structural model, and then using machine learning tools for the residual series, after removal of the seasonal component. Electricity prices seem to appear in certain states so Hidden Markov models will be investigated.

## Computational Design of Innovative Interlayers to Enhance Electrolyte Electrode Interface Stability in Lithium Metal Batteries

Mr ABDUL-RAHMAN ABDUL-RAHMAN<sup>1</sup>

<sup>1</sup>King Fahad University Of Petroleum And Mineral, DHAHRAN, Saudi Arabia

### **Biography:**

*Abdul-rahman Abdalla Abdul-rahman (born December 21, 1995) is a Master's student in Chemical Engineering at KFUPM. His research focuses on interface stability in all-lithium solid-state batteries. He has presented at Khalifa University Chemical Engineering Postgraduate Conference 2025 and Saudi Chapter of American Chemical Society international conference 2025.*

The increasing demand for renewable energy and electrified transportation calls for advanced energy storage technologies. Among these, all-solid-state lithium batteries (ASSLBs) have gained significant attention due to their high energy density and enhanced safety enabled by a solvent-free architecture. However, their practical deployment is challenged by interfacial instability caused by chemical and electrochemical mismatches between the lithium metal anode and solid electrolyte. In sulfide-based electrolytes such as  $\text{Li}_6\text{PS}_5\text{Cl}$  (LPSC), spontaneous reduction leads to heterogeneous, electronically conductive phases that accelerate electrolyte decomposition, induce uneven current distribution, and promote dendritic lithium growth—ultimately degrading battery performance and lifespan.

This study presents a computational framework for designing robust interlayers to stabilize the Li/LPSC interface. Zintl-phase intermetallic compounds were explored as interlayer candidates through assessments of phase stability, lithiation energetics, and electronic properties of decomposition products. First-principles calculations and Density Functional Theory (DFT) were employed to generate comprehensive material data, including phase diagrams, interfacial reactions, stability windows, band gaps, and Nudged Elastic Band (NEB) calculations. Compounds such as  $\text{MgBi}_2$ ,  $\text{MgSb}_2$ , and  $\text{CaSb}_2$  emerged as promising materials, forming wide-bandgap, ionically conductive, and electrochemically stable interphases. These interlayers suppress electron percolation, prevent continued electrolyte reduction, and offer cost-effective, earth-abundant alternatives to conventional bismuth-based materials.

The proposed design principles provide a predictive roadmap for mitigating dendrite formation and solid-electrolyte degradation—two critical challenges in ASSLB development. While the framework relies on 0 K formation energies and does not fully capture kinetic barriers, it significantly reduces trial-and-error approaches and accelerates the discovery of durable interlayers for next-generation lithium metal batteries.

## Consequence Analysis-Based Safety Strategies for Liquefied Ammonia Storage in Ammonia Co-Firing Power Plants

Miss Dahee Kim<sup>1</sup>, Prof Min Chul Lee<sup>1</sup>

<sup>1</sup>Incheon National University, Incheon, South Korea

### **Biography:**

*Dahee Kim is a researcher at the Combustion and Fire Engineering Laboratory, Incheon National University, focusing on hydrogen and ammonia co-firing and related safety studies. Minchul Lee, Professor in the Department of Safety Engineering at the same university, is an expert in combustion and safety and the corresponding author.*

In Korea, a demonstration project on ammonia/coal co-firing in ultra-supercritical boilers was launched in 2023 to reduce carbon emissions from the power sector. The project targets more than 20% ammonia co-firing at the 1,000 MW Samcheok and 340 MW Yeosu coal-fired plants, with commercial operation planned by 2028. However, compared to natural gas, ammonia presents hazards such as toxicity, corrosiveness, and environmental harmfulness. Therefore, strengthening safety measures is essential for decarbonized power plants. Furthermore, as plants rely on external ammonia supply, safe design for storage and supply systems is required to ensure stable fuel availability.

Accordingly, this study estimated the required liquefied ammonia storage capacity for co-firing ratios from 0 to 100% (with 1% intervals), based on an eight-hour operation. In addition, consequence analysis was conducted for a leak scenario (hole diameter = 4 inches), and PHAST simulation was conducted to calculate impact distances for toxicity, flammability, overpressure, and thermal radiation.

The leak scenario assumed up to 60 minutes of continuous release. Results showed toxicity as the most critical hazard, with a maximum impact distance of 13.6 km at 30% co-firing (93.44 tons). For flammability, methane 100% produced no LFL/UFL distances, while with ammonia co-firing the LFL ranged from 12.3 to 20 m and the UFL from 9.6 to 10.3 m. For overpressure at 0.02068 bar, the impact distance was 50.6 m for methane 100% and 90.5 m for ammonia 100%. For thermal radiation, methane 100% resulted in 26.1 m, while ammonia 100% reached 104.9 m. Ammonia co-firing also introduced risks from liquid storage, with early pool fire up to 98.9 m and late pool fire 444.4 m.

The findings confirm toxicity as the dominant hazard in ammonia use. For small-scale storage, reducing tank capacity and increasing tank numbers is safer, with sufficient safety separation distance to prevent domino effects. For large-scale storage, more suitable from a safety perspective. In addition, to mitigate accidents, gas leak detectors, emergency shutdown systems, and transfer pumps are recommended, along with dikes as protective measures for liquid storage.

# Converging Technologies for a Low-Carbon Future: EVs, Solar, and Storage

Dr Nikhil Jayaraj<sup>1</sup>, Dr Subramaniam Ananthram<sup>1</sup>, Dr Anton Klarin<sup>1</sup>

<sup>1</sup>Curtin University, Bentley, Australia

## **Biography:**

*Nikhil Jayaraj, Managing Director of Regen Power Pty Ltd and Research Adjunct at Curtin University. He holds a Doctorate in Business Administration focused on solar energy storage transitions. He has published in leading journals like Energy Policy and Renewable Energy, contributing to research in sustainable energy and policy.*

## Introduction

Nations across the globe are deploying a range of policy and technological strategies to accelerate the adoption of electric vehicles (EVs), with Australia emerging as a prominent player in this transition.. In 2024, the EV adoption in Australia reached an all-time high of 114,000 new registrations, reflecting growing consumer interest aided by supportive policy frameworks. A key milestone in this trajectory is the forthcoming implementation of the National Vehicle Efficiency Standard (NVES) in 2025, which is expected to expand access to zero-emission vehicles and significantly reduce national carbon emissions. These efforts aimed at increasing the uptake of EVs pose simultaneous demands for charging facilities, increasing the stress on the conventional grid. In 2019, global electricity consumption attributable to EVs reached 80 TWh, highlighting the urgent need for sustainable charging solutions. This study investigates the role of EV adoption in driving the uptake of solar and battery storage technologies in Australia. It examines EV charging behaviours and consumer readiness to adopt solar and storage solutions.

## Methodology

The study adopts a multi-stakeholder approach involving key actors relevant to the adoption of EVs, solar, and battery storage systems. A qualitative methodology was employed, using semi-structured interviews with twenty participants, including EV charger providers, solar and battery retailers, consumers, and consultants. Participants were recruited through purposive and snowball sampling techniques to ensure diversity of perspectives. The socio-technical systems (STS) framework guided the analysis, offering insights into the dynamic interactions between technological adoption and broader social, institutional, and infrastructural factors shaping the integration of EVs with solar and storage.

## Results and Discussion

The study enhances the STS framework by integrating institutional and environmental factors. It addresses key gaps, including the limited research treating electric vehicles, rooftop solar, and battery storage as complementary technologies. The study also responds to the lack of multi-stakeholder perspectives, offering a more integrated understanding of the dynamics shaping technology adoption.

## Conclusion

The study contributes to identifying policy frameworks that shape the adoption of EVs and solar energy across Australia and supports the development of integrated models to assess their combined impact on energy markets, infrastructure resilience, and national sustainability objectives.

## Data-Driven Prediction of Operational Carbon in Cold-Climate Railway Halls

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<sup>1</sup>Harbin Institute Of Technology, Harbin,

**Biography:**

*Jingyi Liu is a Ph.D. candidate at the School of Architecture and Design, Harbin Institute of Technology, China.*

*Jianfei Chen is a Professor and doctoral supervisor at the School of Architecture and Design, Harbin Institute of Technology, China.*

Transitioning transport infrastructure toward electrification and carbon neutrality requires precise evaluation of building-related energy use within stations that connect renewable energy systems and passenger mobility. High-speed railway (HSR) halls in cold regions are characterized by large thermal envelopes, fluctuating occupancy, and intensive HVAC demands, making them major contributors to transport-related operational energy consumption. To address the challenge of predicting and reducing operational carbon emissions during the early design stage, this study develops an energy-driven, data-based framework for carbon emission prediction and optimization in cold-climate HSR halls. The workflow integrates Grasshopper-based parametric modeling, Honeybee-enabled dynamic energy simulations, and machine learning algorithms to capture the relationships between spatial design variables and energy performance. A database of 500 simulated scenarios was generated by varying the window-to-wall ratio (WWR), skylight ratio (SR), and ceiling height (CH)—three parameters directly influencing lighting, heating, and cooling loads. Using these datasets, multilayer perceptron (MLP) and Random Forest models were trained to predict annual carbon emissions and assess the sensitivity of energy drivers. Results show that the proposed approach achieved a prediction accuracy of 91.2 %, revealing strong nonlinear interactions among enclosure variables. Sensitivity analysis indicates that optimizing the SR–CH combination can reduce operational energy demand and carbon emissions by up to 19 %, enhancing both energy efficiency and indoor environmental quality. The framework further supports integration with renewable energy supply systems, facilitating adaptive, low-carbon operation throughout the transport building lifecycle. This study provides a quantitative decision-support model for the electrification and energy optimization of transport buildings in cold climates. By coupling parametric simulation, renewable-energy analysis, and AI-driven prediction, it advances sustainable design methods for next-generation railway stations, contributing to the broader transition toward net-zero and energy-resilient transport infrastructure.

## Decarbonisation through Microgrids and DER in Land Development, and additional Network Benefits

Mr Thananjeyan (jey) Shivakumar<sup>1</sup>

<sup>1</sup>Cossill & Webley, Perth, Australia

### **Biography:**

*Jey Shivakumar is the Principal of CW's Energy Transformation Services team. With over two decades of experience in electrical infrastructure. Which includes all electrical works covering underground power (utility, AS3000 compliance), renewable and alternative power. Having worked on the private microgrids in WA, Eglinton Estate, OceanReef and Peel Business Park.*

The land development sector contributes more than 40,000 new residential and commercial power connections each year to local electricity networks across Australia. While this significant additional load often necessitates upgrades or extensions to existing network infrastructure, it also creates a valuable opportunity to support the nation's transition toward a more sustainable energy future. As Distributed Energy Resources (DER) continue to be mandated, incentivised, and integrated into new developments, the pace of decarbonisation can accelerate considerably. Private organisations that prioritise sustainable energy solutions, while still maintaining commercial viability play a crucial role in unlocking this value. Their efforts can extend even further through the implementation of grid-connected microgrids, which offer both economic and environmental benefits.

Over the past five years, I have collaborated with a diverse range of property developers, alongside Western Power, private network operators, and renewable energy service providers, to support the decarbonisation of residential and commercial developments. Through major projects such as Peel Business Park, Ocean Reef Marina, and Eglinton Village, we have demonstrated the tangible benefits that localised private networks, microgrids, and wholesale-integrated DER can deliver. These benefits extend not only to residents who enjoy improved energy resilience, efficiency, and cost stability but also to the wider grid, which gains access to cleaner, more flexible, and more intelligently managed energy resources. Collectively, these projects show that it is possible to advance a decarbonisation pathway that creates mutual value for customers, communities, and network operators, all while operating under financially sustainable models.

In this presentation, I will provide detailed case studies and insights from the three projects listed above. This will include an overview of the development process, identification of technical and regulatory challenges, and a discussion of the practical, economic, and environmental benefits achieved. I will conclude by outlining the ongoing conversations occurring with Western Power, the long-term opportunities we aim to unlock for the network, and a proposed "wish list" of policies, regulatory reforms, and support mechanisms that would further enable and simplify the deployment of sustainable, network-supportive energy solutions across future developments.

## Decarbonising Cement: Kaolin Backfill By-Product (KBB) for a sustainable and standards-ready SCM

Mr Greg Blasiak<sup>1</sup>

<sup>1</sup>Murdoch University, , Australia

*Biography:*

*TBC*

Manufacture of clinker for Portland Cement has become the world's single largest source of carbon emissions. Reducing clinker content in cement is central to lowering the carbon footprint of construction materials and advancing circular economy practices. Metakaolin is well established as a reactive pozzolan, but large-scale adoption is constrained by the need for beneficiated, low-quartz feedstocks. High-purity kaolin products generate substantial residual material: Kaolin Backfill By-Product (KBB), typically disposed due to its limited economic value. Mineralogical analysis shows KBB is composed primarily of kaolinite (~70%) with a significant quartz fraction (~30%). The high quartz content has discouraged valorisation, since quartz is inert and dilutes the reactive metakaolin phase. KBB was transformed into a sustainable and standards-ready SCM through calcination, selective classification, and intergrinding, supported by novel predictive tools. Calcination at 700–820 °C was characterised using Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA/DSC), and quantitative X-ray diffraction, defining conditions for optimal dehydroxylation. A new FTIR Reactivity Index (FRI) was developed and correlated with both alkali-dissolved Si/Al (ICP-OES) and compressive strength of OPC blends at 10–30% replacement. Reactivity was also assessed through a conductivity-based dissolution fingerprint, designed to be implemented as a rapid, plant-feasible tool for quantifying ionic release and benchmarking performance. To address the quartz fraction, quartz trimming via classification removed coarse inert material, while intergrinding with limestone improved particle packing and introduced carbonate nucleation surfaces. A new Net Pozzolanic Contribution (NPC) metric was introduced to decouple dilution from true reactivity. Mortar and concrete testing (AS 1012) showed that KBB at up to 30% OPC replacement achieved strength parity at 28 days and reduced sorptivity, confirming pore refinement and increased density. These findings position KBB as a circular-economy solution: a residual by-product stream, previously relegated to mine backfilling, can be repurposed into a high-value, low-carbon binder. This work demonstrates both environmental and performance benefits. Early markets for this new construction material are expected to be wind turbine & solar farm footings.

## Decarbonising Murdoch University Fleet Using Green Hydrogen Fuel

Dr Furat Dawood<sup>1</sup>, A/Professor GM Shafiullah<sup>1</sup>, A/Professor Martin Anda<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Furat Dawood has a PhD in Chemical and Metallurgical Engineering and is a lecturer at Murdoch University in Western Australia. He is a Global SME Hydrogen, Renewable Energy Expert and Net Zero Emission Consultant.*

In response to the urgent need for dependable, scalable pathways to net-zero by 2050, Murdoch University (MU) has committed to Net Zero Scope 1 and 2 emissions by 2030. MU's Decarbonisation Roadmap 2025–2030 identifies fleet transition as a near-term lever. This study presents a techno-economic assessment of replacing MU's continuously operating security fleet with hydrogen fuel cell electric vehicles (FCEVs), positioning the campus as a replicable living-lab for institutional decarbonisation.

The proposed system couples 100% renewable electricity with on-site electrolysis, buffered hydrogen storage, and a compact commercial hydrogen refuelling package delivering 700-bar dispensing. Green hydrogen is produced preferentially during periods of renewable surplus and dispensed on a schedule aligned to duty cycles and shift patterns. Fleet operational data, including the weekly mileage, baseline petrol use, and refuelling intervals, were extracted from logbooks to size production and storage. Vehicle specifications (Toyota Mirai ~5 kg H<sub>2</sub>, Hyundai NEXO ~6.5 kg H<sub>2</sub>; ~650–700 km range) inform a Phase-1 design target of 5 kg H<sub>2</sub> per day.

We conduct a bottom-up techno-economic analysis quantifying: levelized cost of hydrogen (LCOH), fuel cost per 100 km versus petrol counterfactuals, total cost of ownership (TCO), payback, and NPV under campus tariffs, and well-to-wheel emissions abatement. Sensitivities include electrolyser capacity factor, capital investment, compression and dispensing energy, station utilisation, and escalation of carbon intensity.

Results demonstrate the practical viability of a RE-integrated, small-footprint H<sub>2</sub> mobility system for continuous duty of the MU-security fleets, with clear conditions under which early adoption is competitive and emissions superior. The work offers a transferable design and decision framework for universities, hospitals, and precinct operators seeking near-term fleet decarbonisation without operational disruption.

## Decarbonising the cement and concrete industries with Renewable Energy and Circular Economy

Dr Arsalan A.Ghavanini<sup>1</sup>, Mrs. Ugyen Lhachey<sup>1</sup>, Dr. Furat Dawood<sup>1</sup>, Associate Professor Martin Anda<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Dr. Arsalan A.Ghavanini is a lecturer in School of Engineering and Energy at Murdoch University, specializing in process design, mechanistic modelling, techno economic, and lifecycle analysis with a focus on wastewater treatment, resource recovery, and biotechnological downstream processing to produce value added products.*

It is well documented that the manufacture of Portland cement and concrete is the world's single largest source of carbon emissions at 5-8% of the total and concrete is the second most consumed product after water. These two facts alone would give cause to make this industry a global focus for decarbonisation and it is true that significant efforts are underway by researchers and industry to address this challenge. Industry efforts at decarbonisation include: (1) Alternative fuels, like RDF (refuse derived fuel), for the kilns that produce the clinker used to make Portland cement; (2) Increasing the proportions of SCM (supplementary cementitious materials) to offset the amount of Portland cement in concrete batching – these typically include low-cost, waste-derived materials like coal flyash, ground granulated blast furnace slag (GGBFS) and silica fume; (3) Adoption of calcined clays as SCMs; and (4) Using carbon offsets like certified tree planting schemes.

Cement and concrete companies around the world are increasingly making use of EPDs (Environmental Product Declarations) to promote their lower carbon products but market awareness is still low and more effort is needed to increase the demand for these products. In this study we have modelled and given case studies for three pathways towards further decarbonisation with EPDs: (A) The use of geopolymers as an alternative to Portland concrete. The geopolymer itself is using new waste-derived precursors such as delithiated beta spodumene, instead of commonly used coal flyash which will be in decline as coal power plants begin to shut down. The activator chemicals are made using renewable energy sources. (B) Another type of geopolymer using kaolin calcined at 750degC to metakaolin as the precursor (which is half the temperature of a clinker kiln typically 1,500degC). The calcination kiln can be heated with renewable electricity or hydrogen. (C) The concrete batching, casting and curing plants are powered by renewable energy sources. Each of these methods are compared by presenting the final product in the form of 3 different EPDs (Environmental Product Declarations).

## Decarbonizing 3D Concrete Printing: Optimized Geopolymer Mix Using Calcined Sidoarjo Mud for Sustainable Industry Transition

A/Prof Januarti Jaya Ekaputri, Mr Verdi Rahaditya, A/Prof Martin Anda, Ms. Anjas Handayani, Prof. Himawan Tri Bayu Murti Petrus, Prof. Irwan Katili, Dr. Jessica Sjah, Assoc. Prof. Andri Kusbiantoro, Dr. Puput Risdanareni, Assoc. Prof. Irwanda Laory

### **Biography:**

*Dr. Eng. Januarti Jaya Ekaputri is an associate professor at ITS specializing in green concrete, geopolymers, 3D printing, and bio-mineralization. With over 120 publications, 10 patents, and 70 research grants, she is a leading Indonesian researcher in concrete and the president of the Indonesian Geopolymer Research Consortium (KORIGI).*

The transition toward low-carbon construction materials is a critical component of global decarbonization and Industry 4.0 strategies. Three-Dimensional Concrete Printing (3DCP), as an emerging additive manufacturing technology, offers significant reductions in material usage, labor demand, and formwork dependency. However, the sustainability of 3DCP is strongly influenced by the carbon intensity of its binder system. This study develops and optimizes a geopolymer-based printing material incorporating calcined Sidoarjo Mud (Lusi)—a large-scale environmental waste in Indonesia—as a partial replacement for fly ash to advance decarbonized 3DCP.

A series of fly ash-based geopolymer pastes activated with sodium silicate ( $\text{Na}_2\text{SiO}_3$ ) and sodium hydroxide (NaOH) was evaluated to determine the optimal baseline mixture. Five formulations were examined for open time, workability, shape retention, buildability, and mechanical strength using a custom-built 3DCP system. The optimum mix was subsequently modified by replacing fly ash with calcined Lusi at varying proportions and by applying a controlled heat-treatment approach to enhance structural stability during layer deposition.

A substitution level of 15% Lusi by binder mass produced the most favorable performance, achieving an open time of 25 minutes, initial and final setting times of 151 and 200 minutes, and a 28-day compressive strength of 54.14 MPa. The mixture demonstrated buildability up to 22 layers with a 60-second interlayer interval. Heat treatment accelerated geopolymerization and improved early-age buildability, but required uniform application to avoid premature surface hardening and print-quality degradation.

The study highlights the complex interplay between material characteristics (workability, consistency, setting time, compressive strength), machine parameters (extruder type, extrusion rate, printing speed, material supply), and material–equipment interactions (buildability, open time, standoff distance, SRF), which collectively govern 3DCP performance.

By valorizing a nationally recognized disaster material and reducing reliance on high-carbon cementitious binders, this research provides a technically robust and industrially applicable pathway to decarbonized 3D concrete printing suitable for aggressive and demanding construction environments.

# Defect-Engineered Cobalt-Doped MnO<sub>2</sub> Nanowires for High-Performance Aqueous Zinc-Ion Batteries

Dr Bayan Baatiyah<sup>1</sup>, Dr Mohammed Gondal<sup>1</sup>, Dr Yakubu Wudil<sup>1</sup>

<sup>1</sup>King Fahad University For Petroleum And Minerals, Dahrhan, Saudi Arabia

## **Biography:**

*Bayan Baatiyah is a Ph.D. student in Physics at King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. His research focuses on advanced electrode materials and thin-film engineering for next-generation aqueous zinc-ion batteries, with expertise in electrodeposition, pulsed laser deposition, and electrochemical characterization.*

## **Introduction**

Manganese dioxide (MnO<sub>2</sub>) is widely studied as a cathode material for aqueous zinc-ion batteries (ZIBs) due to its low cost, abundance, and high theoretical capacity. However, its practical performance is hindered by low conductivity, sluggish Zn<sup>2+</sup> diffusion, and structural degradation from Mn dissolution and Jahn–Teller distortion. This study investigates cobalt-doped MnO<sub>2</sub> (Co–MnO<sub>2</sub>) nanowires prepared via electrodeposition, aiming to address these challenges by leveraging defect engineering and nanostructure control.

## **Methodology**

A one-step potentiostatic electrodeposition process was used to synthesize Co–MnO<sub>2</sub> nanowires directly on graphite substrates. Structural characterization was performed using X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), and X-ray photoelectron spectroscopy (XPS). Electrochemical properties were evaluated through cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), long-term cycling, and electrochemical impedance spectroscopy (EIS).

## **Results and Discussion**

The Co–MnO<sub>2</sub> cathode exhibited a high initial capacity of 425.6 mAh g<sup>-1</sup> at 0.5 A g<sup>-1</sup> and retained 246.4 mAh g<sup>-1</sup> at 1 A g<sup>-1</sup>, outperforming pristine MnO<sub>2</sub>. Long-term testing demonstrated 84% capacity retention after 600 cycles at 1 A g<sup>-1</sup>, with nearly 100% coulombic efficiency. XPS confirmed cobalt incorporation and the generation of oxygen vacancies, while FESEM revealed an interconnected amorphous nanowire morphology that enhanced Zn<sup>2+</sup> transport pathways. EIS analysis indicated reduced charge-transfer resistance and improved ion diffusion kinetics. Compared with previously reported MnO<sub>2</sub>-based cathodes, this electrode shows superior stability and rate capability, attributed to the synergistic effects of cobalt doping and nanowire architecture.

## **Conclusion**

This work demonstrates that cobalt-induced defect engineering, combined with amorphous nanowire morphology, significantly enhances the electrochemical performance of MnO<sub>2</sub> cathodes in aqueous ZIBs. The scalable electrodeposition method offers a low-cost and environmentally friendly route for fabricating high-performance electrodes. Future work may explore multi-element doping and interfacial engineering to further optimize Zn<sup>2+</sup> storage mechanisms.

## Design and Implementation of Wireless Control Framework for an Active Axis Wind Turbine (AAWT) Prototype

Mr Jawad Mezaal<sup>1</sup>, Associate Professor Jonathan Whale<sup>1</sup>, Mr Kim Schlunke<sup>2</sup>, Professor Parisa Bahri<sup>1</sup>, Associate Professor David Parlevliet<sup>1</sup>

<sup>1</sup>Murdoch University, Perth, Australia, <sup>2</sup>Sifte Pty Ltd., Perth, Australia

### **Biography:**

*Jawad Mezaal is a PhD candidate at Murdoch University's School of Engineering and Energy. He holds a Master's in Instrumentation and Control Engineering and a bachelor's in Computer Engineering. His research focuses on control systems for Active Axis Wind Turbines, with interests in control theory, embedded systems, and wind energy.*

Wind energy plays an important role in the transition to net-zero emissions, but today's turbines face design challenges that limit their potential. Most current machines are horizontal-axis turbines, built on towers over 100 meters tall with structures weighing hundreds of tons. Due to the large overturning moment, the turbines require a large amount of supporting infrastructure, typically around 15 per cent for onshore and up to 24 per cent for offshore of the total turbine cost. Also, HAWT suffer from stability and safety issues for floating offshore deployment. To address these limitations, this study investigates the Active Axis Wind Turbine (AAWT), a new design that keeps the generator and centre of mass close to the platform or ground, eliminates the need for a tall tower and large concrete foundation, and allows the blades to be actively pitched and tilted. An AAWT prototype was built at Murdoch University to experiment with the concept. An ESP32 microcontroller was used to control the turbine's rotor, which operates in a closed-loop system with a PID controller for stable and safe speed control.

Two wireless approaches were utilised to avoid the drawbacks of using slip rings and wired connections, including ESP-NOW for fast communication between two microcontrollers, and Wi-Fi UDP for sending large data packets to a host. Different sensors were employed, such as an encoder, a torque sensor, an inertial measurement unit (IMU), and an optic sensor. They provided real-time measurements. Laboratory tests showed the system can maintain stable rotor speeds, reaching 300 rpm. Adopting wireless communication has been demonstrated to be fast and reliable for high-frequency transmission. The developed model successfully monitored key operating variables in real time, proving that complex and wired systems in turbine testing can be replaced with distributed wireless control. This research demonstrates the capability of integrating wireless control and monitoring for the AAWT prototype. This system provides a flexible and low-cost framework for this type of wind turbine development. The results represent a significant step toward the design of safer, stable, and affordable wind turbines. Future studies will focus on variable pitch control, performance and stability validation.

## Design of Condition Labels-Based Diagnosis Models for Wind Turbine Rotating Components Using SCADA Data

Mr Xuan-Kien Mai<sup>1</sup>, Dr Jun-Yeop Lee<sup>2</sup>, Dr Minh-Chau Dinh<sup>2</sup>, Dr Seok-Ju Lee<sup>3</sup>

<sup>1</sup>Department of Electrical Engineering, Changwon National University, Changwon-si, Republic of Korea, <sup>2</sup>Research Institute of DNA+, Changwon National University, Changwon-si, Republic of Korea,

<sup>3</sup>School of Aerospace Engineering, Glocal Advanced Institute of Science & Technology, Changwon National University, Changwon-si, Republic of Korea

### **Biography:**

*Xuan-Kien Mai (Mr.) is currently a Ph.D. student in the Department of Electrical Engineering at Changwon National University. His research interests include condition monitoring of wind turbines, control of industrial systems, and applications of AI in electrical engineering.*

The high operation and maintenance (O&M) costs of wind energy remain a major barrier to its wider deployment. Rotating components such as the main bearing, gearbox, and generator account for more than 50% of unplanned downtime, with failures often leading to extended outages and repair expenses that may exceed 15–20% of the turbine's total life-cycle cost. Conventional threshold-based monitoring systems and rule-driven SCADA alarms are limited in sensitivity, frequently generating false alerts or failing to detect early degradation. This underscores the urgent need for a more robust, data-driven diagnostic framework.

This paper presents a condition diagnosis model for wind turbine rotating components that leverages SCADA data and deep learning with labeled operational conditions. The proposed approach utilizes supervisory signals from wind turbines, where operating states are annotated as normal or abnormal based on historical maintenance records and expert labeling. A deep learning architecture is designed to capture condition-related patterns in SCADA signals such as mechanical and lubricant temperatures, rotor speed, and active power. To enhance generalization across different wind turbine types, transfer learning strategies are incorporated, enabling the trained model to adapt to previously unseen datasets with minimal retraining.

Evaluation results demonstrate that the proposed model significantly improves diagnostic accuracy compared with traditional SCADA threshold methods. Specifically, the model detects anomalies an average of 2–3 days earlier and achieves an overall accuracy of 97.62%.

Future research will focus on integrating the diagnostic model into real-time SCADA environments and extending its application to additional subsystems such as pitch and yaw drives. Furthermore, coupling the framework with digital twin technology offers a promising pathway toward predictive maintenance strategies that combine physical modeling with data-driven intelligence, ensuring higher reliability and scalability in large-scale wind farm operations.

### **[Acknowledgements]**

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(RS-2023-00246086).

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) grant funded by the Korea government(MOTIE) (RS-2022-KP002821, Development of durability evaluation and remaining useful life prediction technology for wind turbine life extension).

## Designing Circular Pathways for End-of-Life Energy Infrastructure: Turning Energy Waste into Valuable Commodities.

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### **Biography:**

*Research Fellow in hydrometallurgy with expertise in circular economy systems, lithium-ion battery and e-waste recycling. Research experience includes process flowsheet design, lithium refining, electrochemical processes, and techno-economic analysis, with a focus on sustainable materials recovery and evidence-based evaluation of emerging resource technologies*

A circular economy approach will be essential to sustainably manage the growing volume of end-of-life solar panels, inverters, and lithium-ion batteries associated with the rapid deployment of distributed renewable energy and electric vehicle (EV) infrastructure in urban environments. Cities with high penetration of grid-connected rooftop solar and residential energy storage systems are approaching a critical transition point where large-scale repurposing and recycling pathways must be established to avoid significant environmental and logistical challenges.

Perth, Western Australia, provides a compelling case study. The metropolitan region currently hosts approximately 400,000 rooftop solar photovoltaic (PV) systems, placing Australia among the global leaders in residential solar uptake. New installations and system upgrades continue at an estimated rate of 20,000 to 30,000 systems per year. Rapid technological advancement has resulted in newer systems with higher efficiencies, leading to the premature decommissioning of older panels. Currently, many decommissioned PV panels are exported internationally for processing or disposed of domestically in landfills. However, export pathways are increasingly constrained, and landfill disposal of solar panels is expected to be prohibited across all Australian states in the near future. Beyond PV infrastructure, the demand for lithium-ion batteries is accelerating. Although Perth currently has approximately 10,000 residential battery systems and 25,000 EVs, these figures are increasing exponentially. Anticipated policy changes supporting residential energy storage will further intensify the need for a dedicated home energy repurposing and recycling ecosystem.

A model is presented that outlines two major collection and repurposing operations in metropolitan and rural Perth, establishing the necessary industry partnerships and identifying unique geographical, economic, and technological factors. Materials unsuitable for reuse are integrated into existing glass recycling streams and emerging low-carbon concrete manufacturing processes, ensuring maximum material recovery and value retention. Collectively, this model presents a scalable, regionally adaptable framework for managing renewable energy infrastructure in accordance with circular economy principles.

## Developing Mine Tailings Database to support sustainable Geopolymer Concrete and Industrial Symbiosis practices in WA

Mrs Amitha Varghese<sup>1</sup>, Assoc.Prof Martin Anda, Dr Biji Kurup, Mr Shri Rai

<sup>1</sup>Murdoch University, Murdoch, Australia

### *Biography:*

*My name is Amitha Varghese. I am a Master Research Student in Engineering and Energy Department.*

The construction industry is a major contributor to global carbon emissions, with cement an essential component of concrete responsible for nearly 7–8% of total emissions worldwide. Reducing the carbon footprint of this crucial material is one of the most pressing challenges in achieving sustainable development. A promising solution is to replace Ordinary Portland Cement (OPC) with alternative cementitious materials generated from industrial and mining waste.

Mining and mineral processing industries generate large volumes of tailings and residues that are often stored in tailings ponds, cause serious environmental risks. These waste materials can instead be transformed into valuable resources for producing low-energy, low-carbon geopolymer concrete (GPC). This research focuses on four key industrial by-products suitable as precursors for GPC: fly ash, lithium aluminosilicate residue (LASR), nickel slag, and red mud. Fly ash, rich in amorphous aluminosilicates, is produced by coal-fired power stations and stored in ash dams. LASR, a by-product of lithium refining, also contains reactive aluminosilicates suitable for geopolymerisation. Nickel slag, generated during nickel processing, and red mud, a residue from bauxite refining, both offer potential as GPC precursors due to their chemical composition and pozzolanic activity.

This research aims to develop a comprehensive database of these resources available from the tailings for producing low-carbon, geopolymer concrete for construction industry. The database will compile information such as tailings location, mineralogical and chemical characteristics, volume, and environmental conditions. Using geospatial tools and collaboration with stakeholders, the system will identify optimal sources of raw materials and map potential supply chains connecting tailings facilities to concrete batching plants. A case study will highlight how 70–80 concrete batching plants across WA can be linked with nearby tailings sources and renewable energy infrastructure projects.

This approach aligns with the goals of a Circular Economy, sustainable development, and improving the environmental impacts associated with mining practices and traditional concrete production as aligned with renewable energy infrastructure needs.

Adopting GPC concrete in low energy architecture (precast wall panels, blocks and slabs for houses) and for renewable energy infrastructure (wind turbine foundations and wall towers) will be a great breakthrough in the construction industry to achieve reduced carbon emissions.

## Do residential households respond to dynamic price signals? Evidence from Australia

Mr Ramith Wimalaratna<sup>1,2</sup>, Mr Alexandr Akimov<sup>1</sup>, Mrs Shyama Ratnasiri<sup>1</sup>

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### **Biography:**

*Ramith Wimalaratna is an industry PhD candidate at Griffith University, collaborating with Ausgrid and RACE for 2030 CRC, researching innovative tariffs and demand response for residential and industrial customers. He holds an MSc in Renewable Energy, MBA, and BSc in Civil Engineering, with professional experience in the renewable energy industry.*

Time-varying electricity tariffs are gaining interest as an incentive method to encourage households to participate in demand response (DR). In Australia, only one retailer has introduced a real-time pricing (RTP) tariff, which varies prices every 30 minutes based on wholesale market prices. However, the extent to which households provide DR under such extreme price volatility remains uncertain. This study examines the response of RTP-enrolled households to price signals compared with households on non-RTP tariffs. Household 30-minute consumption data were analysed with a particular focus on solar PV availability. Price responsiveness of demand was calculated, and additional modelling was conducted to assess demand flexibility and tariff impacts. The results show that, on average, households voluntarily enrolled in RTP tariffs exhibit weak responses to price signals. In contrast, households with solar PV systems show a stronger response to price signals, particularly when battery storage with automated control systems is present. This highlights that battery storage, rather than behavioural change alone, is a key driver of residential DR. Notably, price responsiveness was significantly lower during evening peak periods, while midday responsiveness was stronger. Also, our results suggest that tariff-related incentives may act as substitutes for solar generation rather than direct motivators of peak reduction. From a tariff design perspective, the findings suggest that a supplementary lower tariff period during midday could better align with consumer behaviour and solar availability. Although this may reduce retail revenue, modelling suggests that such losses can be offset through a marginal increase in peak-period tariffs. This adjustment could help balance the retailer's revenue shortfalls while supporting system-level objectives. In conclusion, the study demonstrates that RTP tariffs rely heavily on battery storage with automated systems to deliver meaningful DR outcomes. Behavioural response alone, even among voluntarily enrolled RTP households, is limited. Future tariff and policy designs should therefore integrate battery storage with automated systems and complementary pricing structures to unlock the full potential of residential DR.

## Economic Dispatch in Sustainable Microgrids Using Modern Optimization Methods: A State-of-the-Art Review

Mr Olalekan Mudasiru Baba<sup>1</sup>, Dr Olumuyiwa Yinus Odufuwa<sup>2</sup>, Mr Oluwole Joseph Oladunni<sup>3</sup>, Professor Kazumba Kusakana<sup>1</sup>

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### **Biography:**

*Baba O.M. researches renewable energy and a doctoral candidate; Odufuwa O.Y., Senior Lecturer in Mechanical and Mechatronics Engineering, focuses on thermal storage and HVAC optimization; Kusakana K. a full professor at the Central University of Technology; and Oladunni O.J. specializes in industrial process optimization at Durban University of Technology.*

Economic dispatch (ED) is a fundamental optimization problem in power systems, aimed at meeting load demand at lowest operational cost while satisfying generation and network constraints. The increasing integration of renewable distributed generation has transformed conventional ED into complex, multi-objective problem characterized by intermittency, bidirectional power flows, and storage dynamics. This paper presents state-of-the-art review of ten operational microgrids across Africa, Asia, and the United States, focusing on the application and comparative performance of modern optimization and artificial intelligence techniques for sustainable ED. The review evaluates Model Predictive Control (MPC), Reinforcement Learning (RL), Convex Optimization and Mixed-Integer Linear Programming (MILP) methods with respect to computational efficiency, uncertainty management, scalability, and cost-effectiveness. The findings show that the choice of ED approach strongly depends on local resource profiles, data availability, technical expertise and operational objectives. In resource-constrained African microgrids, MILP and convex formulations prevail due to their robustness and interpretability, whereas data-rich systems such as Stone Edge and Brooklyn microgrids successfully employ MPC and RL for adaptive real-time dispatch. The main contribution of this research is a practical framework that links resource availability, data quality, and system objectives to the selection of suitable ED techniques. The analysis further reinstates hybrid optimization, combining model-based and data-driven methods as promising direction for resilient, low-carbon microgrid operation. Future research should validate these hybrid architectures through testbed implementation and cross-regional benchmarking.

## Effect of hydrogen on diesel engine fuelled using corn oil Performance, emission and combustion characteristics

Dr Ravishankar Sathyamurthy<sup>1</sup>

<sup>1</sup>King Fahd University Of Petroleum & Minerals, Dhahran, Saudi Arabia

### **Biography:**

*Dr. Ravishankar Sathyamurthy is an Associate Professor in the Department of Mechanical Engineering at King Fahd University of Petroleum & Minerals (KFUPM), Dhahran, Saudi Arabia. Dr. Sathyamurthy's work emphasizes solar still design, energy-water nexus technologies, and the application of nanomaterials to enhance thermal performance.*

The present study investigates the synergetic effects of hydrogen at the volumetric flow rates of 6 and 12 LPM with 20% corn oil biodiesel COME20 fuelled in a direct injection (DI) diesel engine to assess the thermal performance, emission, and combustion characteristics. Experimental results revealed that introducing hydrogen through the air intake manifold augmented the thermal performance and combustion characteristics with a reduction in HC, CO<sub>2</sub>, CO, and smoke opacity. The brake thermal efficiency at maximum engine load using COME20 with 12 LPM hydrogen flow recorded the maximum efficiency of 35.5%, followed by COME20 with 6 LPM, which is found as 36.2% and higher compared to the conventional diesel fuel and COME20, which recorded 31.21% and higher compared to COME20 biodiesel alone. The BSFC for COME20 with 12 LPM and 6 LPM hydrogen flow was reduced to 0.22 and 0.23

kg/kWh, respectively, whereas, for conventional diesel and COME20 biodiesel, it is found as 0.26 and 0.29 kg/kWh at the maximum engine load. Emissions of carbon monoxide (CO), hydrocarbons (HC), and smoke opacity were substantially reduced,

with CO decreasing by an average of 20.47% and smoke opacity by 43.55% with 12 LPM hydrogen compared to COME20. However, nitrogen oxides (NO<sub>x</sub>) emissions increased due to higher combustion temperatures, highlighting a key trade-off that requires mitigation strategies

## Effectiveness of Flexible Demand Strategies: Evidence from Commercial and Industrial Customers

A/Prof Alexandr Akimov<sup>1</sup>

<sup>1</sup>Griffith University, Gold Coast, Australia

### **Biography:**

*Alexandr Akimov is an Associate Professor in Finance and Deputy Director of Centre for Applied Energy Economics and Policy Research at Griffith University. His two main areas of research are energy and development finance. He has recently contributed to several completed projects sponsored by RACE for 2030 CRC.*

We provide a systematic review of the effectiveness of flexible demand (FD) strategies for industrial and commercial customers and the key elements for their success, utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach to select and analyse 99 relevant scientific studies. Our results show time-of-use (ToU) tariffs to have been the most popular FD incentive documented in the literature. This strategy had been analysed in 46% of the studies, with real-time pricing (27%) and ancillary services (17%) the next most common, while other incentives were only analysed by a handful of studies. Most of the studies focused on the longer-term demand responses of load 'shaping' and 'shifting'; shorter-term responses – load 'shimmying' (8%) and 'shedding' (2%) – were only covered by a small proportion of the literature. For industrial customers, the FD programmes studied were, variously, declared capable of reducing peak demand by up to 50%, shifting up to 3% of load from peak to off-peak hours, reducing electricity bills by as much as 82.6% and electricity load by up to 35%, improving profitability by as much as 50%, and reducing emissions by as much as 20%. In addition, commercial customers variously achieved up to a 16% reduction in peak loads, up to 29% in cost savings, profit improvements of up to 19%, emissions reductions of up to 20%, and a 40% reduction in electricity load. Unsurprisingly, results varied substantially, depending on the particular strategies, baselines and industrial sectors involved. The evidence to date suggests that ToU-based tariff strategies have been the most effective for the iron and steel, paper, and textile and clothing industries, while ancillary-services-based strategies have been the most successful for commercial buildings applications.

## Efficiency in energy management in domestic housing

Mr Tony Book

*Biography:*

*TBC*

A description of a house recently refurbished to a high specification of insulation is given. Additionally a 5.4Kwp PV system, 32 x 2000mha battery storage, underfloor heating and smart controls were added .

The hot water is heated by an electric immersion heater primarily by PV energy diverted by a smart switch which optimises excess energy into battery charging, DHW and EV charging . There is also a log burner ( rated at 7Kw ) in the main living area.

The paper demonstrates several points:-

The base line of about 7000 Kwh per annum is reduced by 80% with the use of PV running in tandem with the battery system. The dwelling is virtually self sufficient 8-9 months of the year. The diversion of power into the batteries, hot water and an EV car accounts for 90% of the received radiation with only 10% being exported.

The financials are of the above are presented together with a discussion of using smart variable utility tariffs that are now becoming increasingly available.

## Efficient green hydrogen production with solid oxide cells (SORCs) for effective storage of renewable energy

Prof Tatsumi Ishihara<sup>1</sup>

<sup>1</sup>International Institute of Carbon Neutral Energy Research, Kyushu University, Fukuoka, Japan

### **Biography:**

*Tatsumi Ishihara now serves as professor in Department of Applied Chemistry, Faculty of Engineering, Kyushu University. At present, he is also director of International Institute for Carbon Neutral Energy Research (I2CNER), Kyushu University. Main research area is Solid Electrochemistry relating to Energy, in particular, solid oxide fuel cells and electrolyser.*

Green hydrogen is CO<sub>2</sub> emission free hydrogen and energy carrier of renewable energy. In this talk, solid oxide electrolysis cell for converting renewable energy will be reported for the effective use of renewable hydrogen. In particular, intermediate temperature solid oxide electrolyzer using LaGaO<sub>3</sub> based electrolyte thin film will be explained. In this study, we prepared micro tubular cell using LSGM thin film by dip coating and co-sintering process. NiO-YSZ porous tube was used for substrate and CeO<sub>2</sub> based oxide layer as a buffer layer for preventing Ni diffusion. LSGM film was deposited with dip coating method and finally co-sintering was performed at 1633K for 3h. The obtained cell shows almost theoretical open circuit potential, suggesting dense film successfully obtained. The electrolysis current density of 0.4A/cm<sup>2</sup> was achieved at 1.6V, 873 K and almost theoretical H<sub>2</sub> formation rate was also observed. Since the largest internal resistance of the cell was IR loss which may be assigned to Ni-Y<sub>2</sub>O<sub>3</sub> stabilized ZrO<sub>2</sub> (YSZ) substrate, effects of infiltration on NiO-YSZ substrate were further studied and it was found that Ce infiltration is effective for decreasing overpotential and IR loss resulting in the increased current density (1.1A/cm<sup>2</sup> at 1,6 V 873K). Degradation performance of the prepared tubular SOEC will be further discussed in detail.

## Electricity Blackouts: Challenges, Causes, and Solutions (the Case of Spain)

Dr Mohammad Bany Issa<sup>1,2</sup>, Dr Pastora María Bello Bugallo<sup>1</sup>

<sup>1</sup>TECH-NASE RESEARCH GROUP, UNIVERSITY OF SANTIAGO DE COMPOSTELA, CAMPUS VIDA, , Spain,

<sup>2</sup>DEPARTMENT OF RENEWABLE ENERGIES, FACULTY OF ENGINEERING AND TECHNOLOGY, PHILADELPHIA UNIVERSITY, , Jordan

Blackouts (BO) in a power system are an unavoidable challenge facing modern energy systems, in particular. They can be caused by several factors, including overloaded transmission lines, natural factors such as ice and wind affecting transmission lines, failure of control or protection systems, sudden changes in grid frequency, and more. Power BO impact national security, economic activity, and public health, and can also bring social life to a standstill due to the impact on transportation and aviation systems. The continued increase in the use of renewable energy sources and their direct integration into the electricity grid is a challenge because renewable energy sources do not produce electricity continuously, which affects the stability of the entire grid. In April 2025, power BO occurred in Spain, Portugal, and parts of France disrupting daily life due to the sudden power outages. The aim of the chapter is to study the power BO, its causes, risks, and solutions. The Spanish electrical system and the BO case of Spain will be analysed. The reasons of the BO will be discussed as well as the solutions. Moreover, the effect of the RESs and the BSS on the electrical grid stability and the power BO. The research concludes with suggestions for enhancing the resilience and stability of the power grid in the context of the global energy transition. Battery storage systems enhance the resilience and stability of the power grid in the context of the global energy transition and prove their effectiveness in reducing power outages.

## Electricity infrastructure resilience: A review of strategies and measures for mitigating bushfire, extreme weather risks.

Mr Donald Azuatalam<sup>1</sup>, Mr. Alex Shreeve<sup>1</sup>, Prof. Rosemary Lyster<sup>1</sup>, Prof. Gregor Verbic<sup>1</sup>

<sup>1</sup>University Of Sydney, , Australia

### **Biography:**

*Donald Azuatalam is a Research Associate at the Centre for Future Energy Networks, School of Electrical and Computer Engineering, University of Sydney, Australia. His research interests include grid integration of renewable energy systems, energy management of distributed energy resources, energy resilience, distribution network cost allocation, and building energy modelling.*

This paper presents an overview of resilience improvement measures for electricity infrastructure, and strategies for mitigating the impacts of bushfire and extreme weather events (EWEs). These measures and strategies are designed to support the concurrent goals of greening the grid (integrating renewable energy sources), smartening the grid (deploying advanced technologies for flexibility and efficiency), and hardening the grid (implementing physical protections and robust planning rules to withstand hazards). By aligning these three dimensions, the paper aims to ensure Australia's power system remains reliable, secure, and adaptable in the face of intensifying climate risks and the ongoing transition to a low-carbon energy future. It provides policymakers, regulators, and industry stakeholders with a clear set of strategies and tools to achieve a more resilient electricity network.

## Energy and environmental analysis applied to different sub-loads of a university office building

Chiara Martone<sup>1</sup>, Maurizio Sasso<sup>1</sup>, Prof Carlo Roselli<sup>1</sup>, Elisa Marrasso<sup>1</sup>, Giovanna Pallotta<sup>1</sup>, Ilenia Perugini<sup>1</sup>, Maurizio Sasso<sup>1</sup>

<sup>1</sup>University of Sannio, Department of Engineering, Benevento, Italy, <sup>2</sup>Politecnico di Torino, Department of Energy, TEBE research group, BAEDA Lab, Corso Duca degli Abruzzi 24, , Italy

**Biography:**

*TBC*

Various methodologies can be employed to evaluate different sub-loads in an office building. These approaches are typically based on either Non-Intrusive Load Monitoring (NILM) or Intrusive Load Monitoring (ILM) techniques, or a combination thereof.

This paper considers a validated methodology available in scientific literature for evaluating sub-load profiles, starting from the total electric load of university buildings located in Southern Italy and applying a disaggregation (or breakdown) approach. Beginning with the whole electric load of the structure under investigation, four different sub-loads have been estimated. Energy and environmental performance indicators were considered to account for the contribution of renewable electricity to the building's sub-loads, based on data available for the Italian power grid provided by the Italian Distributed System Operator (DSO) and the Italian Institute for Environmental Protection and Research (ISPRA). For each sub-load, equivalent CO<sub>2</sub> emissions and the share of renewables are evaluated.

## Energy Monitoring System Integrating NILM and ILM with Machine Learning for Real-Time Load Status Detection

Mr Dionysius Aldion Renata<sup>1</sup>, Mr Heri Nugraha<sup>1</sup>, Mrs Vetri Nurliyanti<sup>2</sup>, Mrs Dannya Maharani Putri Utami<sup>1</sup>, Mrs Asih Kurniasari<sup>1</sup>, Mrs Adinda Prawitasari<sup>1</sup>, Mrs Eka Nurdiana<sup>1</sup>, Mr Arief Kurniawan<sup>1</sup>, Dr Kholid Akhmad<sup>1</sup>, Dr Khotimatul Fauziah<sup>1</sup>, Prof Tania Urmee<sup>3</sup>, Dr Amirmehdi Yazdani<sup>3</sup>

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### **Biography:**

*Dionysius Aldion Renata holds a B.Sc. in Informatics from Universitas Sebelas Maret (2013) and an M.Sc. in Computer Science from Keimyung University, South Korea (2020). He is a Junior Researcher at BRIN, specializing in software engineering, databases, and AI applications for energy management systems.*

Accurate energy monitoring is crucial for assisting efficiency optimisation and smart energy management in residential and corporate settings. Traditional Intrusive Load Monitoring (ILM) necessitates several sensors and substantial wiring which leads to several major issues such as: high maintenance, high cost, less reliable etc. An non-intrusive approach to load monitoring (NILM) can be a solution but it also frequently suffers from poor disaggregation accuracy for small or comparable loads. To address these issues, this study introduces an Internet of Things (IoT)-based hybrid monitoring system that combines both ILM and NILM techniques with lightweight machine learning (ML) algorithms to detect appliances' ON/OFF states in real time. The goal is to create a cost-effective, scalable, and accurate system that can identify individual appliance activity from aggregate energy data with NILM techniques.

The experimental setup includes four representative appliances: an 80 W lamp, a 1 HP air conditioner, a microwave oven, and a personal computer. There are monitored continuously for 24 hours with a 1-second sampling rate. Electrical parameters, including voltage, current, and active power, are measured by a power energy meter connected to a microcontroller via Modbus communication. Data are transmitted through the MQTT protocol to a Single Board Computer Raspberry PI, which performs processing and visualization through a Node Red dashboard. High-resolution data from appliances were used to train multiple deep learning models, including Seq2Seq and Seq2Point architectures with convolutional neural networks (CNN) and long short-term memory (LSTM) networks.

The results show that the proposed hybrid NILM-ILM system achieves high detection accuracy (>95%) with MAPE values less than 2%, proving sensor reliability and model resilience. The load profiles of each appliance have distinct characteristics and steady-state for the air conditioner, transient spikes for the outlet, and fluctuating patterns for the computer, allowing for precise classification. Overall, the integrated system provides an efficient and low-cost solution for real-time energy disaggregation and monitoring. Future research will focus on extending the framework to include predictive analytics and automated load control for smart-grid applications.

## Energy Sharing Solution for Decentralized Off-Grid Power Systems

Dr Natchpong Hatti<sup>1</sup>, Dr. Surasak Nuilers<sup>1</sup>, Mr. Prakob Komeswarakul<sup>1</sup>, Mr. Pichet Pudson<sup>1</sup>, Dr. Kanokvate Tungpimolrut<sup>1</sup>, Dr. Yasunori Owada<sup>2</sup>, Dr. Suparak Srita<sup>3</sup>, Dr. Sangkla Kreuawan<sup>4</sup>

<sup>1</sup>National Electronics and Computer Technology Center (NECTEC), Klong Luang, Thailand, <sup>2</sup>National Institute of Information and Communications Technology (NICT), Koganei-shi, Japan, <sup>3</sup>Rajamangala University of Technology Lanna, Mueang Chiang Mai, Thailand, <sup>4</sup>Real BPM Co., Ltd., Muang Samutsakorn, Thailand

### **Biography:**

*Dr. Natchpong Hatti and Dr. Surasak Nuilers are currently working in the Advanced Control and Electronics Research Group at the National Electronics and Computer Technology Center (NECTEC), Thailand.*

*Their research interests include power conversion systems, motor drive systems, utility grid applications, battery chargers, and renewable energy applications.*

### **Introduction:**

Many rural areas in Thailand still lack access to the national electrical grid, with over 60,000 households remaining unelectrified. To improve quality of life in these communities, standalone off-grid photovoltaic (PV) systems have been deployed. These systems typically consist of solar panels, batteries, and inverters, installed independently in separate buildings without any interconnection.

At Thanphuying Wilai Amattayakun School (TWAS) in Tak Province, over six such off-grid PV systems are in operation. However, this configuration introduces significant challenges. Buildings with high load demand often suffer from energy shortages, while others with low consumption generate excess energy that cannot be shared and is ultimately wasted. Centralized systems or AC coupling solutions are impractical due to high cost, complexity, and the risk of a single point of failure—making them unsuitable for remote settings.

### **Methodology:**

To address this issue, this paper proposes a decentralized energy sharing architecture using Energy Sharing Devices (ESDs). Two types of ESDs are introduced: (1) DC-to-DC ESDs, for sharing energy between systems located nearby through the DC battery bus, and (2) AC-to-DC ESDs, for transferring energy from the AC side of one system to the DC side of another system across different buildings. These ESDs are designed to monitor system conditions and determine whether, when, and how much energy to transfer. The first version uses an offline control algorithm; future work includes IoT integration for real-time decision-making.

The key advantages of this approach include:

- (1) Non-intrusive operation—the original systems do not require modification,
- (2) Low power rating—ESDs handle only the difference in surplus and deficit energy, not total system power, and
- (3) Operational flexibility—users can deploy ESDs selectively based on actual site conditions.

### **Results:**

A pilot deployment of four ESDs at TWAS facilitated the reuse of over 8,000 kWh of previously wasted energy per year from five 5-kW PV systems. The estimated payback period is under three years, highlighting both technical viability and economic efficiency.

### **Conclusion:**

This work presents ESDs which are scalable, modular solution to improve energy efficiency and reliability in rural off-grid systems. Future enhancements with IoT will enable smarter, data-driven energy sharing in decentralized networks.

## Energy Storage: Beyond Electric Batteries

Prof Wasim Saman<sup>1</sup>

<sup>1</sup>University Of South Australia, Adelaide, Australia

**Biography:**

*Wasim Saman is Emeritus Professor of sustainable energy engineering. Since the 1980s, he has been leading collaborative research projects in water heating, energy storage, and building energy performance. In 2012, he received the WREC Pioneer Award . He continues to mentor research teams and provides technical advice to industry.*

With renewable energy swiftly dominating energy supply around the world, reliance on energy storage systems for maintaining secure and reliable supply, and matching supply and demand, has become an essential and rapidly expanding part of the energy supply systems. While electric battery installations are increasing in number, capacity and storage duration, they are unsuitable for medium and long term storage. Many other storage technology options are anticipated to play a significant role in providing the required storage capacity and duration in the future grid.

The paper reviews and evaluates the prospects of available storage technologies and their applications including thermal, hydroelectric, gravity, compressed air and chemical storage. Both small scale systems which can be used behind the meter and larger installations are considered. The paper will overview the applications of thermal energy storage technologies in solar thermal energy generation, high, medium and low temperature applications in industry and buildings. It will also report on the latest thermal battery research, development and manufacturing and its applications in domestic and commercial buildings, and industry, utilising the outcomes of over 2 decades of thermal energy storage research at the University of South Australia using phase change materials.

A number of case studies will demonstrate the economic and environmental benefits of installing thermal batteries to utilise available renewable energy generation and supplement heating and cooling systems in both new and existing buildings.

# Enhancement in Short-term Photovoltaic Power Forecasting based on Signal Decomposition and Machine Learning Optimization

Mr Ahmed Bilal Shahulhameed<sup>1</sup>, Dr Md Abdullah Al Bari<sup>1</sup>, Dr Shahzada Zaman Shuja<sup>1</sup>

<sup>1</sup>Department of Mechanical Engineering King Fahad University of Petroleum and Minerals , Dhahran, Saudi Arabia

## **Biography:**

*KFUPM master's student in Mechanical Engineering with a focus on renewable energy. From solar to storage, and hybrid integration, some research topics are ML-based solar forecasting, biomass–wind and nanomaterial supercapacitors. Past design engineer in India. Written reviews on hydrogen. AJSE PV award. Experienced in AutoCAD, HOMER, SimaPro.*

## Introduction

Increasing penetration of photovoltaic (PV) power necessitates accurate short-term forecasting for maintaining grid stability, optimizing dispatch, and enhancing market operations. Extending Zhou et al. [13], we retain their CEEMDAN-based signal decomposition method but introduce a novel learner—Extreme Gradient Boosting (XGBoost). In place of GRNN, BPnn, GRU, and LS-SVM, XGBoost employs gradient-boosted decision trees to efficiently capture nonlinear feature interactions and threshold effects in structured PV data sets. The goal is a controlled and equitable comparison of forecast performance between PV technologies, isolating the contribution of the learner itself under equal data and methodological conditions.

## Methodology

All datasets, preprocessing steps, and feature structures of [13] are preserved, including plane-of-array irradiance, ambient and module temperature, and DC power data for monocrystalline (m-Si), polycrystalline (p-Si), and amorphous (a-Si) modules. The CEEMDAN algorithm decomposes the power series into intrinsic mode functions (IMFs) and a residue; separate XGBoost regressors are fitted to each component and predictions reconstructed by summation. Hyperparameters are tuned using cross-validated grid search with early stopping for robust generalization. SMAPE, MAE, MRE, and  $R^2$  are employed to assess performance, and statistical significance is verified through the Diebold–Mariano (DM) test. Lag structures, exogenous variables, and prediction horizons are identical to those in the reference study for experimental consistency.

## Results and Discussion

Across all module types, the CEEMDAN–XGBoost setup exhibits superior prediction accuracy and stability. For m-Si, SMAPE  $\approx$  3.97% and  $R^2 \approx$  0.993; for p-Si, SMAPE  $\approx$  5.37% and  $R^2 \approx$  0.993; for a-Si, SMAPE  $\approx$  5.44% and  $R^2 \approx$  0.991. Mean SMAPE and MAE values are  $\approx$  4.93% and  $\approx$  32.6 W. DM statistics ( $\approx$  6.59, 5.45, 5.88) confirm that these improvements are statistically significant. XGBoost is able to capture high-frequency variations due to rapid irradiance changes while being low-frequency stable with less tuning requirements compared to recurrent neural architectures.

## Conclusion

With the CEEMDAN pipeline, datasets, and evaluation metrics constant, XGBoost demonstrates clear advantages in accuracy, robustness, and efficiency in short-term PV power forecasting. Its gradient-boosting framework offers computational speed, fewer preprocessing requirements, and fair interpretability—making it an effective high-performance solution for renewable-energy prediction and grid-integration applications.

## Enhancing Thermal Efficiency in Prefabricated Buildings with Microalgae Photobioreactors: A Case Study from Perth, Australia

Dr Amin Mirabbasi<sup>1</sup>, Prof Tania Urmee, Prof Navid Moheimani

<sup>1</sup>Murdoch University, perth, Australia

### **Biography:**

*Amin Mirabbasi is an architect and PhD candidate at Murdoch University, researching the integration of microalgae photobioreactors into building envelopes for sustainable design. With extensive experience in architecture, construction management, and building systems, he also teaches at Curtin University, specializing in sustainability, façade technologies, and environmental building systems.*

In order to tackle the challenges associated with energy efficiency in severe climatic conditions and to offer ecologically sustainable architectural alternatives, this research investigates the thermal performance of a flat-panel microalgae photobioreactor (PBR) incorporated within a prefabricated "donga" building envelope situated in Perth, Australia. This research addresses a critical sustainability issue: the reduction of indoor thermal buildup without reliance on energy-demanding mechanical cooling systems.

The aims of the investigation encompassed: (1) evaluating the thermal performance of a Photobioreactor (PBR) façade under summertime conditions, (2) contrasting empirical data with computational building energy models, and (3) examining the effects of microalgal culture density, aeration, and solar insolation on thermal flow dynamics. An acrylic PBR panel incorporating *Spirulina* culture was implemented as a replacement for a conventional glass window in one of the identical rooms (Room 2) of a four-room prefabricated structure. The other room (Room 3), fitted with a standard window, served as the control variable. Indoor and surface temperatures were meticulously recorded over several days during periods of peak summer conditions.

Empirical results indicated that the PBR system accomplished an average temperature reduction of 2.8°C during peak daylight hours, which can be attributed to its thermal mass, spectral filtering capabilities, and delayed heat transfer characteristics. The negative heat flow exhibited by the PBR during nighttime further contributed to thermal stability. These findings demonstrated a strong correlation with projections derived from Design Builder simulations, thereby substantiating the model for prospective passive system designs.

This investigation emphasizes the significance of bio-integrated façades in the advancement of renewable energy solutions within the constructed environment. PBRs provide quantifiable advantages in passive cooling, thermal buffering, and daylight modulation, achieved without necessitating mechanical systems or intricate maintenance requirements. The incorporation of microalgae systems into modular, relocatable buildings signifies a scalable, low-carbon innovation with extensive ramifications for sustainable housing in arid and remote locales.

By synthesizing simulation and experimental data, the research presents a persuasive argument for the integration of living energy systems into architectural envelopes, congruent with the objectives of WREC to foster practical, renewable, and regenerative energy solutions within the built environment

## Enhancing Torque Performance of Switched Reluctance Motor for Solar Pump Systems

Dr Kanokvate Tungpimolrut<sup>1</sup>, Mr. Seubsuang Kachapornkul<sup>1</sup>, Dr. Yasunori Owada<sup>2</sup>, Dr. Ruchao Pupadubsin<sup>1</sup>

<sup>1</sup>National Electronics And Computer Technology Center (nectec), Pathum Thani, Thailand, <sup>2</sup>National Institute of Information and Communication Technology, Tokyo, Japan

### **Biography:**

*Kanokvate Tungpimolrut was born in Bangkok, Thailand. He received D. Eng. degree in electrical and electronics engineering from Tokyo Institute of Technology, in 1995. Recently he has been a researcher at the National Electronics and Computer Technology Center. His research interests is the electrical motor and drive system.*

Solar-powered water pumping systems are becoming increasingly popular in remote locations, especially those without connection to the utility grid such as farm irrigation, drinking water supply, forest fire protection, and water sources for wildlife in forest areas.

In this paper, a Switched Reluctance Motor (SRM) is designed for solar pumping systems. SRMs are becoming increasingly important due to their high efficiency, simple construction, inherent fault tolerance, and cost-effectiveness. However, conventional SRMs typically suffer from high torque ripple and low torque density, which can reduce motor lifespan and operational efficiency.

Conventional design of SRM with E-core stator designs often result in high torque ripple and increased material usage for rotor, while segmental rotor designs frequently face magnetic saturation issues. This paper investigates and proposes a three-phase SRM design, aiming to address these challenges by reducing torque ripple, mitigating magnetic saturation, simplifying manufacturing, and improving overall motor efficiency and torque output.

The proposed SRM design features three E-core stator poles positioned at 120-degree angles and five segmental rotor pieces attached to a non-magnetic material core. This E-core stator design creates separate and independent magnetic circuits and flux paths for each phase, which helps in reducing magnetic saturation in the stator structure. The segmental rotor design, combined with specific dimensional ratios of stator poles and rotor segments, allows for a shorter magnetic flux path and eliminates magnetic flux reversal in the stator. Furthermore, this design allows for torque generation in two distinct stages as the rotor segments overlap with the stator poles. This feature is specifically intended to reduce torque ripple.

Simulation results show that the proposed design increases phase torque by 30.8% and average torque by 28.8% compared to a conventional 12/8 SRM and significantly reduces torque ripple by 67.9% compared to a 6/5 segmental rotor SRM.

The proposed SRM design effectively addresses the long-standing issues of high torque ripple and magnetic saturation prevalent in conventional and existing advanced SRM designs. These improvements contribute to extended bearing and motor lifespan, and a reduction in operational vibration and noise.

## Environmental Impacts Assessment of Enhanced Oil Recovery in the Orinoco Oil Belt: Challenges and Sustainable Approaches

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<sup>1</sup>TECHNASE - Universidade de Santiago de Compostela, Santiago de Compostela, Spain

### **Biography:**

*M.Sc. Geological Engineer with over 25 years of experience in Petroleum Geology E&P, Environmental Geology, and G&G Processes for companies like Schlumberger and PDVSA in Venezuela and internationally, interpreting clastic and carbonate environments. University coordinator and professor in various subjects. Tutor Grade for numerous projects. Strategic Planning and Projects Management experience.*

The Orinoco Oil Belt (OOB) is the largest heavy and extra-heavy oil reservoir in the world, covering more than 55,000 km<sup>2</sup>. This vast resource is commercially exploited by numerous companies, each operating within a fragmented concession framework. However, the absence of a holistic sustainability strategy poses significant environmental challenges, particularly as Enhanced Oil Recovery (EOR) techniques are increasingly implemented on a large scale. EOR methods, such as Steam-Assisted Gravity Drainage (SAGD), are employed to reduce crude oil viscosity by increasing reservoir temperature. While these techniques enhance short-term production, they significantly contribute to CO<sub>2</sub> emissions and the generation of H<sub>2</sub>S, thereby posing long-term environmental and safety risks. The widespread adoption of these techniques without integrated environmental policies could lead to irreversible techno-environmental impacts.

This study examines the environmental impacts of large-scale EOR techniques in the Orinoco Oil Belt using field data on CO<sub>2</sub> and H<sub>2</sub>S emissions. Potential CO<sub>2</sub> emissions from techniques such as SAGD could exceed the limits established by the Paris Agreement, thus requiring carefully scheduled exploitation strategies. Moreover, increased H<sub>2</sub>S concentrations pose substantial toxicity risks to both operators and surrounding ecosystems, particularly in thermally enhanced recovery operations. To mitigate these socio-environmental impacts, this study proposes the adoption of both preventive and corrective measures. These include the implementation of carbon capture and storage (CCS) technologies, stricter emission regulations, and real-time monitoring of H<sub>2</sub>S concentrations. In addition, the study highlights the need for a coordinated regulatory framework that prioritizes long-term environmental sustainability alongside oil recovery.

## Environmental sustainability of the soy-based biofuel production policy in Brazil

Dr Régis Rathmann<sup>1</sup>, Beatriz Matias El Assad<sup>1</sup>, Diego Ribeiro do Amaral<sup>1</sup>, Prof Alexandre Szklo<sup>1</sup>, Prof Roberto Schaffer<sup>1</sup>, Joana Portugal Pereira<sup>1</sup>, Gerd Angelkorte<sup>1</sup>, Nathalia Dreyer Breitenbach Pinto<sup>1</sup>

<sup>1</sup>Federal University Of Rio De Janeiro, Rio de Janeiro, Brazil

### **Biography:**

*Graduated in Economics from the University of Rio Grande do Sul (2005), Master in Agribusiness from the same University, and PhD in Energy Planning Program of the Center for Postgraduate Engineering of Federal University of Rio de Janeiro (PPE / COPPE / UFRJ).*

Brazil is committed to expanding the use of biofuels for its energy transition. The 'Combustíveis do Futuro' program includes the National Sustainable Aviation Fuel Program (ProBioQAV) and expands the goals of the National Biodiesel Production Program (PNPB). However, the production of biofuels on a large scale, especially from soybeans, may lead to conflicts over land use and food production, loss of biodiversity, and even emissions comparable to those from fossil fuels. Soybeans, the preferred crop to produce sustainable aviation fuels and biodiesel in Brazil, have the added disadvantage of being an export commodity for animal feed and have already been identified as a cause of deforestation. In addition, crop productivity is being impacted by climate change. In this context, the environmental sustainability and challenges and opportunities arising from the use of soybeans as an input for biofuels production are assessed. The expansion of biofuel adoption in the Brazilian transport sector presents opportunities and challenges. Soybean stock is little affected by the biofuel production mandate. Emissions reductions also have a net positive impact, but this does not take into account the potential effects of land use change, biodiversity, and productivity losses caused by the increased intensity and frequency of extreme events in Brazil. Climate change would affect soybean stocks, requiring the incorporation of new productive areas, which could result in deforestation and biodiversity loss, especially in the Cerrado biome. In addition, the high cost of producing advanced liquid biofuels, resulting from the market structure and the way soy biofuels are priced in Brazil, especially SAFs and biodiesel in relation to fossil fuels, still needs to be overcome. The study contributes to the improvement of biofuel policies in the country by assessing the market structure and environmental impacts of the soybean-based liquid fuel production chain. However, the environmental analysis is partial, as it does not measure the effect of land use change caused by increased demand for soybeans for energy purposes, which may undermine the environmental gains associated with net emissions reductions

## Evaluating Energy Storage on the Rottnest Island Wind/Solar/Diesel Microgrid using MS-Excel based Energy Flow Analysis

Mr Craig Carter<sup>1</sup>, Mr Stephen Anderson<sup>1,2</sup>, Dr Martina Calais<sup>1</sup>, Dr Gloria Odo<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia, <sup>2</sup>Woodside Energy, Perth, Australia

### **Biography:**

*Craig Carter has been an Adjunct Professor at Murdoch University, since 2013. In 2024, he was awarded an Honorary Doctorate for his contribution to renewable energy education and research at Murdoch University and related community voluntary work. Craig help develop many pioneer wind, solar and hybrid systems in Western Australia.*

### **Introduction**

Renewable energy penetration rarely reaches 50% in wind/solar/diesel microgrids, without battery storage.

Battery storage can make wind and solar the dominant energy sources, with diesels providing backup. The aims are to analyse the addition of lithium batteries and to accurately determine the optimal quantum of wind, solar and battery storage to minimise costs. The wind/solar/diesel microgrid on Rottnest Island, located off Fremantle, WA, was used to develop a modelling process to determine the optimum mix.

### **Methodology**

Versatile Microsoft Excel, rather than specialist software like 'Homer Pro', was used to achieve reliable modelling of the actual and proposed microgrid control algorithms. Excel was previously used to analyse the Rottnest Island microgrid in 2005, when the existing 600kW wind turbine was proposed.

Accurate modelling requires at least one year's hourly average system load data and site-specific wind data. Historic load data was up scaled to match current and forecast loads. In 2016, a 500kW solar farm was integrated into the Rottnest system. To assess the accuracy of the Excel model, solar generation was added to the model, which was then used to model the current operation of the Rottnest wind/solar/diesel microgrid. Modelling results were compared with the 'Energy Overview' page on the 'Rottnest' phone App. Battery storage was added to the Excel model, so that the benefits of battery spinning reserve and energy time shifting can be included to determine the extra wind and solar, that can be economically accommodated on Rottnest Island.

### **Results and Discussion**

The energy flow modelling indicated that substantially increasing wind and solar, together with the support of a right-sized lithium battery, can be effective in reducing costs. It halved the levelised cost of energy on Rottnest Island down to 16 cents/kWh.

### **Conclusion**

The inclusion of battery storage substantially reduces errors, where hourly average wind and solar data is used in energy flow modelling. Diesel scheduling is no longer affected by large wind and solar fluctuations within each hour. The battery smooths out the short-term power fluctuations. The use of versatile spreadsheet software like Excel can accurately assess the benefits of including battery storage in wind/solar/diesel microgrids.

## Experimental Investigation of Hydrogen–Ethanol Enrichment Effects on Gasoline Engine Combustion, Performance, and Emissions

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<sup>1</sup>King Fahd University Of Petroleum & Minerals, Dhahran, Saudi Arabia

### **Biography:**

*Medhat A. Nemitallah, Associate Professor, holds BS and MS from Alexandria University and a PhD jointly from KFUPM and MIT. With postdoctoral research at MIT, he specializes in clean combustion, hydrogen production, and carbon capture, collaborating with MIT, ARAMCO, SABIC, Air Products, and the U.S. DOE.*

This study investigates the effects of hydrogen enrichment on combustion, performance, and emissions in a port-fuel injection spark-ignition engine operating with an E30 blend (30% ethanol, 70% gasoline by volume). Hydrogen was introduced at varying energy share (HES), 0% to 50% HES to evaluate its impact across multiple ignition timings (IG), IG14°–22° BTDC under constant operating conditions of 50% load, 1500 RPM. The results demonstrate that increasing HES significantly enhances combustion phasing and efficiency. At 22° BTDC, peak pressure increased from ~39 bar at 0% HES to ~44 bar at 50% HES, and peak temperature increased from ~1850 K to ~1960 K. Heat release rate (HRR) and pressure rise rate (PRR) became sharper and more concentrated, with PRR peaking at 2.8 bar/CAD at higher HES. Combustion duration and ignition delay were reduced with HES increase and spark advance. Ignition delay at IG 14° dropped from 11.2 CAD at 0% HES to 7.6 CAD at 50% HES, indicating improved flame development and combustion stability. Indicated mean effective pressure (IMEP) declined from ~4.5 bar to ~3.7 bar as HES increased, due to combustion phasing effect and volumetric efficiency losses from hydrogen displacing intake air. Indicated specific fuel consumption (ISFC) showed consistent reduction with HES increase, its value decreased from ~380 g/kWh to ~275 g/kWh at 22° BTDC. Emission analysis showed CO<sub>2</sub> reduction of ~21%, while NO<sub>x</sub> increased by ~90%, from ~5 to >30 g/kg-fuel, highlighting the need for NO<sub>x</sub> control strategies. Overall, hydrogen enrichment in E30 blends improves combustion efficiency and emissions but requires careful calibration to balance performance and thermal-emission trade-offs.

## Experimental study of sheltering effect for horizontally measured global solar radiation using a pyranometer

Prof Keh-Chin Chang, Mr. Hung-Hsun Chen, Mr. Yi-Da Chung

<sup>1</sup>National Cheng Kung University, Tainan, Taiwan

### **Biography:**

*Dr. Keh-Chin Chang is now the professor emeritus of Department of Aeronautics and Astronautics in National Cheng Kung University, Taiwan. He has authored and coauthored over 200 archival articles. His current research topics cover solar thermal applications, solar resources in Taiwan, etc.*

Experimental study of sheltering effect for horizontally measured global solar radiation using a pyranometer

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The pyranometers installed at the weather stations are usually on their roofs with horizontal altitude. Measurements of global solar radiation there are often subjected to the shelter problems from their surroundings. As a result, corrections of the measured global solar radiation, due to the sheltering effect on the pyranometer from its surrounding, need to be taken into consideration for assuring data quality of which the impinging sunshine on the pyranometer is supposed to come from whole sky dome. Evaluation of the sheltering effect on measurement of global solar radiation is performed by introducing the shelter view factor. Determination of the shelter view factor is performed using a fisheye-lens photograph associated with an available calculation method. A weather station (Taitung weather station, TWS) in eastern Taiwan is firstly chosen for study. The shelter view factor for the pyranometer installed at TWS is evaluated as 11.8%. In the meantime, measurements of global solar radiation were conducted at a place which was located nearby TWS but under a condition of zero shelter view factor to provide a comparison basis. Differences of global solar radiation between the data measured at the two sites are in the range of 4% - 25% obtained in various months in a year. It shows a need of the correction to the sheltering effect for the measuring data of global solar energy at TWS. One more case at a different weather station located in western Taiwan will be studied through a similar comparison process with the data measured at a nearby site but under a condition of zero shelter view factor. The shelter effect will be present at this weather station to highlight the universality of the correction need for the measurement data of global solar radiation provided by a weather station.

## Experimental Study on Leakage Detection for Solar Thermal Systems Using Pressure Indices

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### **Biography:**

*I am a Ph.D. student at UST, Korea, and a student researcher at KIMM. My research focuses improving the reliability and operational safety of renewable energy systems including PV and solar thermal systems. My research also focuses on power-to-heat (P2H) technologies, for enhanced grid flexibility and system performance.*

### **Introduction**

Solar thermal systems are widely used for sustainable heating and contribute significantly to reducing greenhouse gas emissions. However, their long-term performance is often compromised by operational faults, among which fluid leakage is one of the most critical. Leakage not only reduces system efficiency but can also lead to complete failure if undetected. Conventional leak detection methods often require additional sensors or manual inspection, increasing system cost and complexity. Therefore, this study aims to develop a sensor-free, cost-effective method for early leak detection using pressure behavior analysis in solar thermal systems.

### **Methodology**

An experimental approach was employed on a rooftop-installed solar thermal system equipped with evacuated tube collectors (8 m<sup>2</sup>), a 500 L insulated vertical storage tank, a 19 L expansion tank, and a variable-speed circulation pump (Grundfos UPS 15-62 130). A make-up pump (KIP Co. Ltd) controlled by a pressure switch (activation at 68.6 kPa) was used to refill HTF during pressure drops. The HTF consisted of a water–propylene glycol mixture. Key parameters—system pressure, HTF temperature, flow rate, and pump power—were continuously monitored using a pressure transducer (Seta 5260E), type T thermocouples, a turbine flow meter (KTR-550-F), and a digital power meter. Data were collected every two seconds under real outdoor conditions (15–37°C ambient temperature; 0–1000 W/m<sup>2</sup> solar irradiance). After establishing baseline data, leaks were simulated by adjusting a drain valve downstream of the storage tank, with HTF loss measured using an electronic scale. The system was monitored for 24 hours under leak conditions.

### **Results and discussion**

Two dimensionless pressure indices were developed based on real-time pressure data. These indices showed clear, consistent trends that effectively distinguished leak events from normal operation. A significant drop in index values was observed during leaks. The method demonstrated high accuracy and robustness under dynamic conditions, confirming its effectiveness without extra sensors.

### **Conclusion**

This study presents a practical, sensor-free leak detection method validated through real-world experiments. The proposed indices are effective, low-cost, and easily integrable into existing monitoring systems. Future work will focus on broader field validation and adaptation for diverse system configurations and climates.

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# Ezero AI: An AI-Driven Forecast–Decision–Dispatch Framework for Sustainable and Resilient Energy Management

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## **Biography:**

*Dr. I-Yun Lisa Hsieh is an Associate Professor at National Taiwan University (NTU). She earned dual B.S. degrees from NTU and a Ph.D. from MIT. Her research focuses on sustainable energy systems, integrating quantitative modeling and policy insights. She serves on the editorial board of Communications Earth & Environment.*

## Introduction

The rapid transition toward net-zero requires energy management systems that extend beyond monitoring to provide predictive, adaptive, and multi-objective control. Traditional systems often struggle to simultaneously manage electricity cost, carbon emissions, and grid stability, particularly across heterogeneous and multi-building environments. This study introduces Ezero AI, an integrated framework designed to address these challenges through the convergence of advanced forecasting and optimization.

## Methodology

Ezero AI integrates solar forecasting, demand prediction, and multi-objective optimization into a unified forecast–decision–dispatch loop. The solar forecasting module (CL-SUNSET) employs self-supervised contrastive learning on sky imagery for high-resolution, 15-minute-ahead photovoltaic generation prediction. Building energy demand is modeled through K-means clustering combined with BiLSTM architectures, capturing diverse load dynamics across campuses and facility clusters. These predictive outputs feed into a multi-objective optimization model with dynamically adjustable weights to balance carbon reduction, cost efficiency, and peak load management, enabling adaptive scheduling of storage and renewable resources.

## Results and Discussion

Simulation and pilot-scale studies were conducted across multiple facility types, including campuses, logistics hubs, and commercial sites. Results demonstrate that Ezero AI reduces peak demand by more than 50% and achieves carbon emission reductions of 25–45%, while also lowering electricity costs. Compared with conventional energy management approaches that rely on simple storage scheduling or monitoring-only functions, Ezero AI provides a significantly higher level of adaptability and performance. The integration of vision-based solar forecasting and multi-building load modeling further enhances system reliability and supports grid interaction. These findings underscore the potential of AI-driven predictive control in enabling more resilient and sustainable energy management strategies.

## Conclusion

Ezero AI demonstrates how combining high-resolution forecasting with multi-objective optimization can effectively address the intertwined challenges of cost, carbon, and grid resilience. The framework contributes to advancing AI-enabled solutions for sustainable energy transitions and offers practical pathways for large-scale deployment in diverse facility contexts. Future work will extend the framework to incorporate additional modules such as wind forecasting and vehicle-to-building integration, further enhancing its versatility for renewable-rich energy systems.

## Fractional PI Controller for LCL filter

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<sup>1</sup>Murdoch University, Perth, Australia

### Biography:

Tashi Wangmo is an Engineering and Energy student at Murdoch University. Her research focuses on robust control system design for power electronics with applications in microgrids. She has practical expertise in PLC-based control and industry experience in microgrid projects, bridging theoretical knowledge with real-world implementation for sustainable energy solutions.

### I. INTRODUCTION

The integration of renewable energy sources into modern grids requires robust control strategies to ensure power quality and system stability. Voltage source converters (VSCs) connected via LCL filters are commonly used to attenuate switching harmonics. However, the resonance introduced by the LCL filter makes conventional proportional integral (PI) controllers sensitive to grid impedance variations and disturbances, often resulting in degraded stability margins [1]. To overcome these challenges, this paper investigates a Fractional-Order PI (PI $\lambda$ ) controller, where the fractional order  $\lambda$  introduces an additional tuning parameter that allows better shaping of the frequency response and damping of oscillations [2].

### Method

The closed-loop system is modelled in the s-domain with the inverter, LCL filter, and PI $\lambda$  controller represented as:

$$C(s) = K_p + K_i/s^\lambda = (K_p s^\lambda + K_i)/s^\lambda$$

For a unity feedback system with plant  $G(s)$ , the transfer function is:

$$Y(s)/R(s) = C(s)G(s)/(1+C(s)G(s))$$

The corresponding fractional-order characteristic equation becomes:

$$P(s) = Ke^{(-\theta s)} (K_p s^\lambda + K_i) + \sum_{i=1}^n a_i s^i$$

Substituting  $s=j\omega$ , the complex root boundary (CRB) is derived as:

### Result

To illustrate the influence of the fractional order  $\lambda$ , simulations were carried out on an LCL-filtered grid-connected inverter modeled by

$$G(s) = (Ke^{(-\theta s)}) / (a_3 s^3 + a_2 s^2 + a_1 s + a_0)$$

Where  $K = 1$ ,  $a_3 = 6.8 \times 10^{-11}$ ,  $a_2 = 7.4 \times 10^{-9}$ ,  $a_1 = 3.3602 \times 10^{-3}$ ,  $a_0 = 0.18$  and  $\theta = 0.001$  [3].

The Critical Root Boundary (CRB) analysis (Figure 2) was performed for  $\lambda$  ranging from 0.1 to 1.0. It confirms that when  $\lambda \approx 0.38$  the proposed PI $\lambda$  controller stabilizes the LCL system with a wide feasible region of proportional and integral gains ( $K_p$ ,  $K_i$ ). In contrast, at  $\lambda=1$  (classical PI) the stability region vanishes, placing the system outside the left-half plane and making it unstable. The most robust performance is observed for  $0.1 \leq \lambda \leq 0.4$ , where the controller provides strong damping and resilience to parameter variation.

Further verification with the step-response simulation confirms that the proposed controller sets convergence to the set-point with negligible overshoot and essentially zero steady-state error.

### CONCLUSION

This study shows that FOPI control outperforms traditional PI control in providing robust stability and strong resonance damping for LCL transient and steady-state performance by taking advantage of the extra fractional order  $\lambda$ .

# Frequency Control in Transition: Evaluating the Adequacy of FCAS Under Declining Inertia in the NEM

Miss Elisabeth Hale<sup>1</sup>

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## **Biography:**

*Elisabeth Nadya Hale is a Master of Energy Systems student at the University of Melbourne with a background in engineering and industry experience in the energy sector. Her academic interests span energy markets, policy, and the technical challenges of integrating renewable energy into modern power systems.*

## **Introduction**

Australia's National Electricity Market (NEM) is undergoing a profound structural shift as synchronous generation retires and inverter-based resources (IBRs) dominate new capacity. The existing Frequency Control Ancillary Services (FCAS) framework was designed for a high-inertia grid in which frequency deviations were naturally buffered by rotating mass. As inertia declines, these physical foundations erode, exposing limitations in the existing market and legal design. This study asks whether the FCAS framework remains fit-for-purpose in a low-inertia, high-renewable NEM and what reforms are required to maintain stability and efficiency.

## **Methodology**

The paper undertakes legal and comparative policy analysis. It reviews statutory and rule-based provisions in the National Electricity Law and National Electricity Rules, assesses recent regulatory inquiries, specifically the Nelson Review (2025) and the AEMC Efficient Provision of Inertia Final Determination (2025), and benchmarks Australia's approach against Ireland's DS3 Program and Great Britain's Stability Pathfinders. The analysis integrates market data from AEMO and AER reporting, regulatory submissions, and peer-reviewed literature to evaluate structural adequacy and reform feasibility.

## **Results and Discussion**

Findings show that while the FCAS framework's co-optimised dispatch and performance-based standards remain robust, it suffers from three systemic weaknesses: (1) inertia is unpriced and procured only through long-cycle network investments, creating operational inflexibility; (2) cost-allocation and participation rules exclude most distributed energy resources (DERs), distorting accountability; and (3) legal fragmentation separated frequency, inertia, and voltage services across different entities, preventing integrated optimisation. International experience demonstrates that structured procurement, mandatory inverter standards, and unified system-services markets can maintain frequency security under high renewable penetration without excessive intervention.

## **Conclusion**

The study proposes a coordinated reform pathway centred on structured inertia tenders, expanded DER participation, dynamic causer-pays allocation, and unified Essential System Services governance. Together these measures translate the Nelson Review's vision into an implementable, performance-based framework capable of sustaining security and market efficiency as Australia approaches a net-zero grid. Future research should test quantitative co-optimisation models for frequency and inertia procurement to validate these design principles under high-IBR scenarios.

## Fueling the future for rural Africa: A comparative study of clean cookstoves and anaerobic digestion

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***Biography:***

*Amina Batagarawa is an Associate Professor and academic leader with expertise in education, energy, and gender. She leads research projects, chairs the Energy Transition Programme at Women in Renewable Energy Association of Nigeria, and represents Africa and Gender on the World Renewable Energy Network.*

Africa is destroying her forests for firewood. Over 90% of the sub-Saharan population in Africa relies on firewood and charcoal for cooking and heating, accounting for more than 80% of total energy consumption in the region. This leads to erosion, desertification and climate change. For rural dwellers who predominantly use firewood for cooking, it causes health challenges and drudgery. African governments have been promoting some potential solutions like clean cookstoves and anaerobic digesters. This study aims to comparatively analyse the potential for clean cookstoves and anaerobic digestion for efficient cooking in rural Africa. A case study approach is employed to examine the case of some selected countries in West, East, South, North and Central Africa. The analysis covers the policy and adoption of selected cookstoves and digester models promoted by the government in those countries. The expected results are an identification of policy direction requirements for clean cookstoves and anaerobic digesters for rural communities; identification of some products made by local manufacturers and based on these, compare the potential of the two groups of products for rural communities in Africa. This study provides policy direction for clean cooking in rural Africa. The significance of the study also has an impact on the health and livelihoods of rural dwellers and climate action.

## Functional Membrane Design for Eutectic-Based Flow Batteries

**Prof Liwei Wang<sup>1</sup>**

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**Biography:**

*Liwei WANG (L.W. Wang) is a professor in the Institute of Refrigeration and Cryogenics, Mechanical Engineering School, Shanghai Jiao Tong University. The research experience of Prof. Wang mainly focuses on the materials, cycles, and systems for energy conversion of low grade thermal energy with the technology of solid sorption.*

Flow batteries (FBs) have demonstrated promising prospects for large-scale energy storage applications owing to their flexible design, high safety, high efficiency, and high reliability. Among them, eutectic-based flow batteries have emerged as a transformative flow battery system since the eutectic electrolytes provide many advantages, including easy synthesis, affordable cost, environmental friendliness and high solubility. As an essential component of eutectic-based flow batteries, membranes allow charge-balanced ions transport to form a complete electric circuit, while providing separation of catholyte and anolyte. Herein, the fundamental structure-morphology-property relationship was established firstly in the functional membrane utilized for eutectic-based flow batteries. Then, the ion transport channels and membrane classifications based on different transport mechanisms were introduced. Correspondingly, substantial efforts focusing on optimizing the membrane fabrication methods, exploring novel membrane materials and modifying the membrane performance through size and/or the Donnan exclusion effect are illustrated. Finally, future directions for membrane design to realize practical implementation and boost the commercialization of eutectic-based flow batteries are also anticipated. This work attempts to provide feasible strategies to figure out suitable directions for the advancement of this field.

## Generative Design and Multi-Objective Optimization of Net-Zero Vertical Transportation Hubs

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### **Biography:**

*Wang Jiaqi, female, born in June 2001, is currently a doctoral candidate at the School of Architecture and Design, Harbin Institute of Technology. Her research focuses on cold-region rail transit station areas, low-altitude economy, and urban air mobility.*

The transition toward sustainable urban mobility necessitates the development of integrated transportation infrastructure targeting net-zero emissions. In recent years, the emergence of eVTOLs has advanced urban air mobility (UAM) as an efficient, low-carbon, and sustainable new mode of transportation. In this context, this study proposes an innovative computational design framework that synergistically integrates parametric generative design with multi-objective optimization to develop high-performance vertical transportation hubs combining rail transit and UAM. The methodology establishes a dynamic linkage between key architectural parameters—such as roof morphology, façade articulation, and volumetric configuration—and critical performance indicators, including on-site photovoltaic energy generation, operational and embodied carbon emissions, and microclimatic environmental quality. A genetic algorithm is employed to navigate the complex solution space and generate a Pareto frontier of optimal design alternatives, thereby explicitly balancing competing objectives such as energy self-sufficiency, carbon minimization, and pedestrian-level wind comfort.

This framework is applied and validated using Beijing, China, as a case study. As the capital and a globally influential megacity, Beijing presents an urban context characterized by high density, significant seasonal variations in solar radiation and temperature, and strong policy mandates for green transportation and carbon neutrality. Through field investigation and data collection, local meteorological data, urban spatial constraints, and regional carbon intensity factors were integrated. The optimization process yielded a spectrum of context-responsive hub morphologies. Results indicate that compared to conventional designs, the proposed solutions substantially reduce whole-life carbon intensity while achieving high on-site renewable energy generation. Key adaptive strategies emerging from the optimization include photovoltaic canopies optimized for solar energy capture and aerodynamic building forms designed to mitigate seasonal wind impacts. In summary, this study contributes a forward-looking, data-driven design tool that advances the practical implementation of performance-oriented sustainable infrastructure in high-density metropolitan environments.

## Good and Bad Renewables: How Australia can speed-up the transition with better planning and regulation.

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<sup>1</sup>Parliament Western Australia, Fremantle, Australia

***Biography:***

*Dr Brad Pettitt was first elected to the Legislative Council of the WA Parliament in 2021.*

*Until taking up this role in the State Parliament, Brad was the Mayor of the City of Fremantle.*

*Prior to this Brad was the Dean of the School of Sustainability at Murdoch University.*

Australia's energy transition from energy dependence on fossil fuels to renewable sources is gathering pace, as it must if we are to meet key emission reduction and climate change targets. This inevitably means that Australia will be installing a record amount of renewable energy, along with energy storage and transmission, in the decade ahead.

This paper examines how Australia can ensure that this unprecedented renewable energy rollout is done with the least environmental impact.

The paper will examine how good planning for renewable energy, alongside the use of renewable energy zones, and scaled-up and connected smaller-scale projects, can ensure the path to 100% renewable energy is done well.

It will also look at best practice examples and planning, as well as highlighting some of the proposed projects that deserve special scrutiny, as their direct environment impacts may outweigh their indirect benefits in addressing global climate change.

Like all industrial developments, large-scale renewable energy projects can have adverse effects on native vegetation, biodiversity, and cultural and scenic values if done in the wrong place or poorly. Done well, renewable energy can help protect our precious environmental places from direct environmental damage and the growing impacts of climate change.

## Green Synthesis of 5-HMF from Rice Husk Using Deep Eutectic Solvents and Metal Salts

Mr. Subham Halder<sup>1</sup>, Asst. Prof. Shang-Cyuan Chen<sup>2</sup>, Dr. Feng-Chih Chou<sup>1</sup>, Ms. Chien-Hua Hsiao<sup>1</sup>,  
Prof. Yuan-Chung Lin<sup>1</sup>

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### **Biography:**

*Yuan-Chung Lin is a distinguished professor in the Institute of Environmental Engineering, National Sun Yat-sen University, Taiwan. He is the director at the Center for Emerging Contaminants Research of National Sun Yat-sen University, Taiwan. He is also the coordinator of the National Science and Technology Council, Taiwan.*

**Introduction** – The accelerating environmental crisis and rapid depletion of fossil fuels have intensified the search for renewable alternatives. Lignocellulosic biomass (LCB) is one of the most abundant and eco-friendly feedstocks for producing biofuels and bio-based chemicals. LCB consists of cellulose, hemicellulose, and lignin, providing a rich carbon source for chemical transformations. A particularly valuable derivative is 5-hydroxymethylfurfural (5-HMF), a versatile platform chemical with applications in polymers, fuels, and pharmaceuticals. Its production from cellulose involves hydrolysis of cellulose to glucose, isomerization to fructose, and dehydration to 5-HMF. Microwave (MW) irradiation has been explored to improve efficiency due to rapid heating and its ability to overcome LCB recalcitrance. Catalytic systems, including metal salts, deep eutectic solvents (DESs), and ionic liquids (ILs), further accelerate conversion, while solvents like dimethyl sulfoxide (DMSO) enhance selectivity and stabilize intermediates.

**Methodology** – LCB residues – rice husk, sugarcane bagasse, corn cobs, and wheat straw, were collected across various regions of Taiwan. The reaction used choline chloride (ChCl)-based DESs,  $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ , and Amberlyst-15 (A-15) as catalysts. A typical mixture contained rice husk powder, 1:1 ratio of A-15 and  $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ , 0.1 ml DES/IL, 10 ml of DMSO and DI water ratio, subjected to MW irradiation at high temperature. Products were analyzed via high-performance liquid chromatography (HPLC).

**Results and Discussion** – LCB composition was determined using the NREL method. Rice husk had a cellulose content of 33.85%, promoting faster fructose dehydration and higher 5-HMF yields. Among solvents, ChCl-CA DES gave 48.7% yield, attributed to strong hydrogen-bond interactions. Catalyst optimization showed that A-15 combined with  $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$  produced a maximum yield of 60.3% due to synergistic Lewis and Brønsted acidity, enhancing sugar dehydration.

**Conclusion** – Rice husk was effectively used as a sustainable feedstock for 5-HMF under MW irradiation. The combined effect of A-15/ $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$  in BMIM/[Cl] within a DMSO- $\text{H}_2\text{O}$  system efficiently facilitated cellulose hydrolysis, glucose isomerization, and fructose dehydration. This strategy converts agricultural residues into valuable chemicals, promoting green chemistry and sustainable energy production.

## Groundwork for a Dynamic Model: A Mixed-Methods Approach to Social Acceptance of Renewable Energy

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### **Biography:**

*Current PhD Candidate at UTS*

For renewable energy to succeed, it is not enough to develop the technology, but people must be willing to adopt and accept it. Yet, most acceptance models treat people's decisions as fixed, ignoring how our lives, communities, and world keep changing. Factors such as digitalisation, family roles, social influence, and the uncertainty captured by the VUCA world (volatility, uncertainty, complexity, ambiguity) all shape how people think about renewable energy. This study lays the groundwork for a more dynamic way of studying acceptance, focusing on solar energy as a case in point.

A sequential exploratory mixed-methods design was employed. Semi-structured interviews with ten diverse stakeholders including homeowners, industry experts, government representatives, and academic experts explored perceived barriers and drivers such as affordability, declining feed-in tariffs, battery costs, and sustainability concerns. Thematic insights informed the design of a survey instrument targeting latent constructs including affordability, awareness, trust, environmental concern, and digital/social influence. Additional constructs identified through the literature and interviews including risk perception, VUCA perceptions, knowledge, and literacy were also incorporated to ensure comprehensive coverage of factors influencing technology acceptance. Ethical safeguards included informed consent and unique participant IDs to ensure anonymity and withdrawal rights.

Analysis produced a conceptual model of interrelated but non-overlapping constructs influencing acceptance, ranging from perceived economic value and risk perception to social norms, digital readiness, and VUCA perceptions. Findings suggest that solar PV adoption is driven by cost savings, environmental motives, and installer trust, while battery acceptance hinges on safety, warranty, and resilience under outages. This design provides a replicable pathway for linking qualitative insights to quantitative measurement.

This study offers a flexible and people-centered methodology that can help researchers and policymakers understand why communities choose (or resist) renewable energy. The next steps will test this model through statistical validation (SEM), check its real-world relevance with focus groups, and expand it into dynamic modelling to capture how acceptance shifts over time.

## HILS-Based Advanced Design of Protection Schemes for MVDC Systems in Renewable Energy Source Integration

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### **Biography:**

*Dr. Minh-Chau Dinh received his B.S. in electrical engineering from Hanoi University of Science and Technology (2010) and M.S./Ph.D. from Changwon National University, Korea (2012, 2016). He worked at KEPCO Research Institute (2016–2018) and is now a research professor at Changwon National University, focusing on power systems, and wind energy.*

In Korea, the distribution grid has recently received a lot of participation from distributed sources such as wind power, solar power, etc. as well as charging stations for electric vehicles, making it more complicated. MVDC systems, with the advantages of flexible power control, requiring less installation space (for substation and power carrier) than AC systems, are used to connect wind farms to the grid or installed to expand the traditional AC distribution grid to create a hybrid distribution grid between AC and DC. With the ability to flexibly coordinate power flow, the AC/DC hybrid distribution grid is able to overcome local overload points and increase the ability to absorb distributed power sources. However, protection design for DC grids is more difficult than AC grids because there is no zero-crossing point, fault currents increase rapidly, fault detection and isolation are difficult, DC circuit breakers are limited, and standards are not yet mature.

In this study, we propose feasible algorithms for fault detection in MVDC grid such as overcurrent protection, undervoltage protection, protection based on current and voltage change rate..., then evaluate the accuracy, sensitivity and execution time of each method, select the most suitable protection algorithms and combine them together to form an overall protection algorithm for MVDC grid.

The protection scheme is validated based on HILS (Hardware-in-the-loop-simulation) method. A prototype DC relay is fabricated and embedded with the proposed protection algorithms. A hybrid AC/DC grid is also simulated using RTDS to generate different grid operating conditions such as overload and fault. RTDS is used to provide fault voltage and current signals to the DC relay to evaluate its performance.

The protection algorithms achieve an operating time of about 1ms and an accuracy of over 90%. This research result is the basis for developing DC relays for future MVDC grids.

[Acknowledgements]

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(RS-2023-00246086).

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) grant funded by the Korea government(MOTIE) (20225500000060, Operation System for AC/DC Hybrid Distribution Network).

## How to change a diesel truck into a zero-emission truck that out performs its original design?

Mr Clayton Franklin

Join Clayton Franklin, founder and Chief Engineer of EPCA, as he shares the inside story of Australia's first 100-ton battery-electric haul truck retrofit. How do you turn a diesel truck into a zero-emission truck that outperforms its original design? And why does retrofitting offer a faster, more practical path to decarbonising mining fleets?

Clayton will pull back the curtain on the engineering breakthroughs, challenges, and surprising lessons learned from the CAT777 retrofit project. He'll explain why mining operations need to rethink charging strategies, energy management, and even how haul roads are built. He'll also share exclusive data from EPCA's field testing, showing how battery-electric trucks can match, and sometimes beat, diesel trucks in real-world mining conditions.

More than just a technical talk, this session challenges the status quo. If miners don't act now, will they be forced to rely on imported electric trucks, ceding control to foreign manufacturers? Or can homegrown innovation keep Australia's mining sector in charge of its own future?

## Hybrid Desiccant-Enhanced Evaporative Cooler with Integrated Ice Storage for Peak Shifting and Humidity Management

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### **Biography:**

*Tolulope Ekunseitan is a Mechanical Engineering postgraduate and Olumuyiwa Yinus Odufuwa, a Senior Lecturer, Dept. of Mechanical & Mechatronic Engineering, Central University of Technology, Free State, South Africa. Research interests include energy management, ice thermal energy storage, solar-HVAC systems, renewable energy and cooling technologies, and applied artificial intelligence.*

Conventional evaporative coolers are defeated by high humidity, reducing comfort and performance. In the present study, the twin challenge of providing affordable, efficient cooling to low-income households while mitigating grid pressure during peak hours is confronted. A hybrid system featuring a solid desiccant wheel for pre-dehumidification with an indirect evaporative cooler and an Ice Thermal Energy Storage (ITES) unit was simulated and analyzed using Engineering Equation Solver and an Artificial Neural Network. The ITES was intended to charge on off-peak electricity. System performance was simulated by a dynamic building energy simulation model for a typical South African low-income house under hot and dry climatic conditions. Critical parameters compared were the cooling rate, the humidity ratio, indoor comfort, and energy consumption compared with a direct evaporative cooler as a reference and with a conventional AC unit. Indoor comfort temperatures (25°C, ~50% RH) were sustained even during the peak periods by the hybrid system. It achieved an estimated 87% saving of on-peak hours energy consumption over traditional AC with off-peak ice production to its benefit. The desiccant unit kept up with the latent loads such that the evaporative cooler could run at its maximum level of efficiency. This translates into enormous cost savings and off-peak electricity load reduction in the grid. The hybrid ITES-desiccant system offers a practical, climate-tolerant cooling technology. It extends the application of evaporative cooling into drier months, brings significant energy and cost savings, and is well-suited for hot, high-economy locations with low electricity prices. Experimental verification and optimization of the energy source used for desiccant regeneration will be addressed in future research.

## Hybrid Hydrogen Infrastructure: A Review of Technical, Economic, and Environmental Feasibility

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### **Biography:**

*Samy Fahmy (BSc, MBA, MSc) is a Lead Contracts Engineer at Mubadala Energy, with extensive experience in O&G across Africa, SEA, and the GCC. He is associated with Murdoch University's School of Engineering and Energy, where his research focuses on the technical, economic, and environmental feasibility of hybrid hydrogen infrastructure.*

### **Introduction:**

The transition toward Net Zero emissions is accelerating the adoption of hydrogen as a core component of sustainable energy systems. Hybrid hydrogen infrastructure models that integrate existing natural gas networks with hydrogen systems are emerging as a practical, cost-effective interim solution. These models leverage established gas infrastructure to facilitate early hydrogen distribution while avoiding the high financial and environmental costs of constructing new dedicated networks. By progressively substituting natural gas with hydrogen, such systems can contribute significantly to decarbonization targets. However, challenges, including hydrogen embrittlement, material degradation, energy losses, and operational safety constraints, persist. Therefore, there is a need to understand, to what extent can hybrid hydrogen infrastructure serve as an effective transitional pathway toward full hydrogen integration in national energy systems? ' This paper review and synthesize existing knowledge on hybrid hydrogen infrastructure as an intermediate step toward full hydrogen integration, focusing on its technical feasibility, economic implications, and environmental performance. The review will consolidate global evidence and provide a comparative understanding of hybrid system effectiveness under varying regional and technical conditions.

### **Methodology:**

This research conducts a scoping and umbrella review of existing literature and case studies on hydrogen blending, pipeline repurposing, and dual-fuel gas transmission systems. The analysis encompasses data from international pilot projects, national hydrogen backbone plans, and techno-economic assessments. Key focus areas include the technical challenges of blending hydrogen with natural gas, retrofitting requirements, cost-benefit evaluations, and the role of hybrid systems in reducing emissions during the energy transition. Additionally, the study explores the use of life-cycle-based approaches to evaluate environmental performance, with emphasis on identifying best practices in existing assessment methodologies.

### **Findings:**

Current literature affirms the potential of hybrid hydrogen systems to reduce deployment costs and emissions; however, critical gaps persist. These include insufficient performance data on retrofitted infrastructure, inconsistent LCA system boundaries, and the lack of integrated techno-economic-policy assessment tools. Addressing these requires standardized modelling approaches and harmonized evaluation metrics. A comprehensive framework is recommended to guide policymakers and support evidence-based policy and infrastructure investment decisions.

### **Keywords:**

Hydrogen infrastructure, hybrid systems, natural gas blending, pipeline repurposing, techno-economic analysis, life-cycle assessment.

## Hybrid Physics-Informed Residual Algorithm for Accurate and Interpretable Photovoltaic Power Prediction

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### **Biography:**

*I am a student and researcher at Universidad Católica de Cuenca, Ecuador. I study Robotics and Artificial Intelligence, and Digital Business and Finance. My main research interests focus on intelligent systems, physics-informed models, and renewable-energy forecasting. I enjoy exploring how AI and data-driven innovation can support sustainable technologies.*

The rapid global expansion of photovoltaic (PV) generation and the transition toward digitalized smart grids demand predictive models that remain both accurate and physically consistent. Purely data-driven approaches often achieve low numerical errors yet violate basic thermodynamic behavior—predicting power at night, ignoring inverter clipping, or misrepresenting temperature effects. To overcome these limitations, this study introduces a hybrid Physics-Informed Residual Neural Network (PINN-Residual) that merges first-principles modeling with deep learning for interpretable PV power forecasting.

The proposed framework integrates PVWatts, Huld, Faiman-Koehl and a simplified Sandia inverter equation within a unified structure. On top of this physical baseline, three neural architectures—Fully Connected (FC), Gated Recurrent Unit (GRU), and Transformer—learn additive ( $\delta_a$ ) and multiplicative ( $\delta_b$ ) residuals constrained by a time-adaptive physics loss. The model was trained and validated on the PVOD v1.0 dataset (stations 00, 04, 08) using chronological 70/10/20 splits and a leakage-free Leave-One-Station-Out (LOSO) cross-validation to assess generalization across sites and climates. The GRU-PINN achieved the best balance between numerical precision and physical realism, reaching MAE = 0.073 MW and  $R^2 = 0.98$ , with 35–60 % RMSE reduction versus standard MSE baselines. The Transformer-PINN offered slightly higher temporal smoothness under rapidly varying irradiance, while the FC-PINN provided competitive accuracy at lower computational cost. The residual components exhibited clear diagnostic meaning:  $\delta_a$  captured gradual module degradation, whereas  $\delta_b$  reflected inverter and wiring losses.

In conclusion, coupling data-driven architectures with embedded PV physics significantly enhances reliability, interpretability, and cross-site robustness. The hybrid PINN-Residual algorithm represents a practical step toward physics-aware digital twins for large-scale solar plants, enabling predictive maintenance, adaptive control, and improved integration of renewable energy into future smart grids.

## Hydrilyte®: A Reversible System for Hydrogen Storage, Purification, and Transport

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<sup>1</sup>Carbon 280, East Rockingham, Australia

### **Biography:**

*Mark Rheinlander is the Founder and CEO of Carbon280 Pty Ltd, developing hydrogen storage and transport technologies. Previously, he founded Calytrix Technologies, scaling it from concept to profitability in four years. At Carbon280, he raised over AUD 16 million to build the Hydrilyte® Research Facility and leads pilot-scale commercialisation efforts.*

The global transition to renewable energy depends on efficient and scalable hydrogen storage and transport technologies. Conventional methods such as compression and liquefaction are energy-intensive and costly, while chemical storage often lacks reversibility. Hydrilyte®, developed by Carbon280, is an innovative reversible hydrogen carrier designed to enable safe, low-cost storage, purification, and transport of hydrogen under ambient conditions. The system addresses key challenges in hydrogen distribution and buffering, supporting industrial decarbonisation and natural hydrogen utilisation.

The Hydrilyte® process operates through a single-step reversible hydrogenation-dehydrogenation cycle using a proprietary solid–liquid composite material. Laboratory and pilot-scale tests have evaluated hydrogen uptake, release kinetics, and operational stability, supported by thermodynamic and process modelling to assess scalability and system integration. Pilot-scale validation is underway at Carbon280's Hydrilyte® Research Facility in Western Australia, in collaboration with exploration and energy partners.

Preliminary findings indicate that Hydrilyte® can store and release hydrogen under mild temperature and pressure conditions, significantly reducing energy use and complexity compared to existing technologies. Its reversible nature supports cyclic operation and integration with renewable hydrogen production and natural hydrogen recovery. Modelling results suggest potential reductions in capital and operating costs, enabling modular deployment in industrial and mobility applications. Hydrilyte® provides a practical pathway to safe and economical hydrogen storage and transport, advancing the decarbonisation of energy-intensive sectors and demonstrating the promise of reversible solid–liquid hydrogen carriers for a cleaner energy future.

## Hydroxy-acid leaching of metals from spent Li-ion battery coatings and direct regeneration of cathode material

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<sup>1</sup>Prairie View A&M University, Prairie View, United States

### **Biography:**

*Ananda S. Amarasekara is the Texas A&M University System Regents Professor at Prairie View A&M University in Texas, and he received his Ph.D. from the City University of New York. His research interests are renewable energy and catalysis. He is the author of more than 160 research publications.*

**Introduction:** Wide use Li-ion batteries in electric vehicles, electronics and other energy storage applications have resulted a need to recycle valuable critical metals Li, Ni, Mn and Co in these batteries.

**Methodology:** In this work an aqueous mixture of hydroxy acids as well as sugar solutions under oxygen atmosphere are shown as excellent leaching agents to recover these critical metals from spent Li-ion batteries.

**Results and Discussion:** An aqueous acid mixture of 0.15 M in glycolic and 0.35 M in lactic acid showed the highest leaching efficiency of 100, 100, 100 and 89% (w/w) leaching for Li, Ni, Mn and Co in an experiment at 120 °C for 6 hr. Evaporation of water from chelate solution gave a mixed metal-hydroxy acid chelate gel. Pyrolysis of the dried chelate gel at 800 °C for 15 h. could be used to burn-off hydroxy acids, regenerating lithium nickel manganese cobalt oxide without precipitation of metals as hydroxide or carbonates. A comparison of leaching efficiencies of hydroxy acid mixtures and in-situ generated hydroxy acids using sugars will be presented.

**Conclusion:** We have developed an inexpensive and scalable method for regeneration of active cathode material in spent Li-ion batteries for fabrication into new batteries.

## Impact Evaluation of a Carbon-Aware Datacenter Ecosystem for Renewable Integration

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### **Biography:**

*Researcher, Energy Network Technology Group, Space Environment and Energy Labs., NTT, Inc. She has worked on energy-related research since joining NTT in 2019, focusing on carbon-aware datacenter operation, energy demand forecasting, and optimization toward green ICT operations that support renewable integration and regional sustainability.*

The large-scale deployment of renewable energy is amplifying temporal and spatial imbalances in electricity supply and demand, often leading to curtailment. At the same time, electricity consumption from datacenters (DCs) is rapidly increasing worldwide, already accounting for 1–2% of global demand. When operated in a carbon-aware manner —such as shifting workloads across multiple DCs or over time in response to renewable generation profiles— DCs can serve as flexible demand-side resources that actively support grid decarbonization. However, frameworks that connect such efforts with Creating Shared Value (CSV) remain limited.

This study proposes a carbon-aware DC ecosystem as a framework in which DCs pursue the 24/7 Carbon-Free Energy (CFE) goal through green operations while contributing to mitigating regional supply–demand gaps and strengthening CSV. In this framework, DCs flexibly coordinate their operations with renewable generation to support the formation of a shared-value energy ecosystem. As an initial step, we conduct a case study in Japan by analyzing two scenarios: a Business-as-Usual (BAU) case reflecting current DC siting and operations, and a Future Vision case that introduces greater flexibility in both location and operation. In both scenarios, the power mix is assumed to consist of 80% variable renewables (solar and wind), 10% dispatchable renewables (hydropower, geothermal, and biomass), and 10% stable sources (e.g., fossil with Carbon Capture and Storage (CCS) and nuclear). Time-series profiles of both electricity demand and renewable generation, capturing seasonal and diurnal variability, are applied to evaluate spatio-temporal impact. Results are compared against the BAU baseline to assess environmental and operational benefits.

Findings show that coordinated workload shifting across DCs can effectively expand renewable utilization and mitigate imbalances, thereby reducing curtailment and enabling greater use of regional renewable resources. In addition, this approach fosters a shared-value energy ecosystem in which green ICT operations actively support regional economies and energy transitions. These results provide quantitative evidence that integrating carbon-aware DC operations into renewable energy planning can accelerate decarbonization while enhancing the stability of both ICT services and the electricity system.

## Integrated Aero-Electro-Mechanical Modeling and Generator Reduced-Order Model for a 2 MW DFIG Wind Turbine

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### **Biography:**

*Jun-Yeop Lee and Minh-Chau Dinh received Ph.D. degrees in Electrical Engineering from Changwon National University and work on physics-informed reduced-order modeling and fatigue diagnosis of wind turbines. Seok-Ju Lee, School of Aerospace Engineering, Global Advanced Institute of Science & Technology, supervises research on electric machines, power conversion, and digital-twin applications.*

This study presents an integrated aero-electro-mechanical modeling framework and a finite element based reduced-order model (ROM) of the generator for a utility-scale wind turbine. The goal is to combine high-fidelity electromagnetic analysis with system-level dynamics so that generator behavior is represented accurately without prohibitive computational cost. A 2 MW doubly fed induction generator (DFIG) wind turbine is used as a reference platform. A physics-based dynamic model of the 2 MW DFIG turbine is developed in Modelica, including aerodynamic loading, drivetrain dynamics, and pitch and yaw control. This system model is coupled to a detailed electromagnetic model of the DFIG to represent the dependence of electrical outputs on operating slip. The generator is simulated using a two-dimensional transient finite element method, and a parametric study is performed over a representative range of slips and loading conditions. For each operating point, the finite element analysis provides rotor voltage, air-gap flux, electromagnetic torque, and electrical power. These results are then used to construct a data-driven ROM that maps slip to key electromagnetic quantities while preserving their physical trends. The resulting generator ROM is integrated into the wind turbine simulation environment, forming a computationally efficient digital twin that maintains consistency between aerodynamic loading, mechanical response, and electromagnetic power conversion. Simulation studies show that the ROM closely reproduces finite element results across the target slip range while reducing computation time by more than an order of magnitude, enabling extended time-domain studies and rapid scenario analysis. The proposed framework provides a systematic path to embed high-fidelity electromagnetic behavior into turbine-level models through a finite element informed ROM of the generator. The integrated model forms a basis for future extensions toward stress-based assessment, fatigue analysis, and health monitoring within a unified digital twin environment for wind turbines.

### [Acknowledgements]

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(RS-2025-25396743)

## Integrating Social Dimensions in Renewable Energy Transition of Rural Area: Potential impact on Women Empowerment

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### **Biography:**

*Apriani Dorkas Rambu Atahau is a Professor of Management in the Faculty of Economics and Business, Satya Wacana Christian University. She completed her Ph.D. in Curtin University, Australia. Her research interests are banking and finance, pension fund, microfinance, gender and energy. She has published many articles in reputable international journals.*

East Sumba Regency, one of Indonesia's disadvantaged frontier regions, holds significant renewable energy potential through the Sumba Iconic Island program. However, research on embedding social and environmental considerations into energy planning remains limited. This study addresses the urgency of transitioning to renewable energy as a strategy to reduce carbon emissions and mitigate climate change. Aligned with the Sustainable Development Goals (SDG 7: Affordable and Clean Energy; SDG 13: Climate Action), the transition must also integrate social dimensions, including women's empowerment (SDG 5) and child labor. Existing literature shows that the relationship between gender and energy transition is complex, context-specific, and shaped by cultural norms. Neglecting these social aspects risks undermining the long-term viability of the transition. This study therefore aims to (1) define the scope of Social Life Cycle Assessment (SLCA) in East Sumba's energy transition, (2) Investigate the potential impact on energy value chain for women empowerment. Using questionnaires distributed to sample in Kamanggih subdistrict East Sumba, the data is analyzed with PLS-SEM. Preliminary findings indicate the existence of interlinkages among stakeholders in ensuring the sustainability of the energy transition. This contrasts with the findings of Fortier et al. (2019), which confirmed the presence of child labor, whereas the present study found no evidence of such practices. This discrepancy is likely attributable to the implementation of the nine-year compulsory education program and the strong kinship networks in Sumba, which function as a coping mechanism for households in managing economic challenges. In addition, a proposed value chain for women empowerment as a result of renewable energy transition is provided. The study implies the need to focus on renewable energy sustainability by taking into account a more holistic approach in women empowerment.

## Integration of Green Hydrogen as a Kiln Fuel in Bhutan's Cement Industry: A Feasibility Study

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<sup>1</sup>Murdoch University, 90 South St, Murdoch, Australia

### **Biography:**

*Ram Chandra Dahal is a Master's student at Murdoch University, passionate about innovation, technology, and environmental sustainability. His recent research explores the feasibility of integrating green hydrogen as a decarbonisation pathway for Bhutan's cement industry, aligning with the nation's carbon-neutral and energy diversification goals.*

Bhutan's cement industry plays a significant role in national development but remains heavily dependent on coal-fired kilns for clinker production, which conflicts with Bhutan's constitutional commitment to carbon neutrality. This study evaluates the feasibility of integrating green hydrogen as a kiln fuel through a case study approach. Using a mixed methods framework that combines case analysis, expert interviews and feasibility analysis based on available data, the research explores the technical, economic, infrastructural and policy dimensions of the green hydrogen production for the hard-to-abate cement industry sector.

The findings indicate that while the integration of green hydrogen is technically feasible, it is currently not economically and infrastructurally viable. Based on regional price estimates of green hydrogen in Asia (USD 6.95-7.2/kg), and the current proposed hydrogen site at Gidawom, Thimphu, this study finds that the cost of cement will increase between thirteen to fifteen times, making it noncompetitive under the current conditions. Bhutan's challenging geographical terrain and limited industrial scale and market size further limit its feasibility.

This study concludes that hydrogen alone cannot serve as a standalone decarbonisation solution. Complementary strategies such as clinker substitution, process efficiency, biomass and refuse-derived fuels (RDF) important in reducing CO<sub>2</sub> emission as well as alternatives to cement need to be explored as a holistic approach to reducing greenhouse gas. This research recommends initiating a modular hydrogen plant at the cement factory, phase-wise hydrogen transition strategy, developing hydrogen policy acts, carbon credits and financial incentives to make green hydrogen integration both economically and logistically viable in Bhutan.

## International partnerships for decarbonisation and business developments: the case of sustainability education in Lombok, Indonesia

Dr David Zhang<sup>1</sup>, Associate Professor Martin Anda

<sup>1</sup>Murdoch University, MURDOCH, Australia

### **Biography:**

*Dr David Zhang, Academic Chair at Murdoch Business School, is an award-winning educator with 25+ years' transnational experience. He leads sustainability and cross-cultural initiatives, designing immersive, community-focused learning through COIL, HyFlex, and WIL. Recognised nationally and internationally, he empowers students to foster employability, global competence, and real-world impact.*

Communities in developing countries, particularly in Eastern Indonesia and on Lombok Island, face significant risks to their long-term well-being. Issues such as climate change, poverty, water shortages, and waste management make it hard to achieve environmental, economic, and social stability. Higher education plays a key role in raising awareness and encouraging action by involving local communities and industries in hands-on projects. On Lombok, the collaboration between Murdoch University and University of Mataram (UNRAM) is leading the way with projects that focus on reducing carbon emissions and supporting new businesses. This phase features three focused areas led by students and staff: utilizing locally made geopolymer and rice straw panels instead of imported cement, transitioning from shark fishing to ecotourism and sustainable community development, and replacing water-intensive home sanitation systems with constructed wetlands. Three main methods are used: Experiential Learning Theory (ELT), Work-Integrated Learning (WIL), and Technology-Enhanced Learning (TEL). Students enhanced their sustainability learning with immersive, on-site experiences. They work closely with local communities and industry partners, experimenting with different sustainability strategies.

Since 2021, 70 Murdoch University students from 43 disciplines have co-designed 25 practical proposals with communities in Southeast Lombok, seeking sustainable livelihoods. To date, 18 of these have been successfully implemented. These initiatives address food security, access to clean water, pollution reduction, renewable energy, well-being, gender equality, and livelihood diversification. In the same region, 135 UNRAM students developed community-based initiatives that engaged local youth and supported sustainable fishing and eco-tourism efforts. Through the collaborative efforts of both universities, these ongoing projects nurture curiosity, foster cognitive, behavioural, and emotional growth in students, enhance graduate employability, and develop sustainable communities through sustained partnerships and international collaboration. The next phase of the project will expand these community initiatives by connecting graduate students involved in research projects focused on decarbonization with industries, thereby benefiting communities, education, and research. This transition aims to attract investment for community-based sustainable business developments and will be leveraged by sustained educational efforts for student and community learning, thereby creating a lasting impact.

## Introduction of Robotic In Manufacturing of Low Carbon Concrete for Sustainable Cities - WREC 2026

Mr Maheswaran Arumugam, Dr Martin Anda, Dr Hai Wang

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Mahesh Arumugam is a Mechanical Engineer with over 20 years experience in the Robotics, Designing soft tool and sheet metal Manufacturing, Completed his Bachelor of Engineering (Hons)*

*degree at The University of Sunderland,(UK) and currently completing Accelerated Research Masters Training (ARMT) for the path way for PhD in Murdoch University.*

It is well documented that the manufacture of Portland cement and concrete is the world's single largest source of carbon emissions at 5-8% of the total and concrete is the second most consumed product after water. These two facts alone would give cause to make this industry a global focus for decarbonisation and it is true that significant efforts are underway by researchers and industry to address this challenge. Industry efforts at decarbonisation include: (1) Alternative fuels, like RDF (refuse derived fuel), for the kilns that produce the clinker used to make Portland cement; (2) Increasing the proportions of SCM (supplementary cementitious materials) to offset the amount of Portland cement in concrete batching – these typically include low-cost, waste-derived materials like coal flyash, ground granulated blast furnace slag (GGBFS) and silica fume; (3) Adoption of calcined clays as SCMs; and (4) Using carbon offsets like certified tree planting schemes. Cement and concrete companies around the world are increasingly making use of EPDs to promote their lower carbon products. but market awareness is still low and more effort is needed to increase the demand for these products. In this study we have modelled and given case studies for three pathways towards further decarbonisation with EPDs: (A) The use of geopolymers as an alternative to Portland concrete. The geopolymer itself is using new waste-derived precursors such as delithiated beta spodumene, instead of commonly used coal flyash which will be in decline as coal power plants begin to shut down. The activator chemicals are made using renewable energy sources. (B) Another type of geopolymer using kaolin calcined at 750degC to metakaolin as the precursor (which is half the temperature of a clinker kiln typically 1,500degC). The calcination kiln can be heated with renewable electricity or hydrogen. (C) The concrete batching, casting and curing plants are powered by renewable energy sources. Each of these methods are compared by presenting the final product in the form of 3 different EPDs. Majorly using Drone for quality check and control with thermal Camera and the total system work with Automation which use Robotic technology supported with sensors.

## Key & Sub Assessment Factors of Sustainability Verification System in Buildings A Local Approach

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<sup>1</sup>DCEC, Ltd, Baghdad, Iraq

### **Biography:**

*Dr. Raed graduated as architect in 1995 from Baghdad University and his PhD in Sustainable Architecture was in 2018. He joined DCEC (Dijlah) in 2004 and played a pivotal role in its diverse portfolio of projects. He was involved in participation in JVs for Japanese loans and other international firms.*

This research concentrates on finding the most efficient method(s) to reach the mechanism of assisting architects, engineers, and other relevant competent and experts to verify the co-existence of values and sustainability constituents in construction projects. The problem of this research is summarized in a clear local forfeit in the interest to embed a system of values in addition to a list which cares about comprehending to which extent building components consider sustainable building criteria.

Furthermore, the hypothesis shows that heading towards an applicable sustainable building approach requires formation of a local assessment system used as a tool for the evaluation of buildings during their life cycle, and from which buildings will be under one of two categories: sustainable and non-sustainable, partially or completely, with precise ratings.

Research aims at establishing key and secondary concepts contribute together to form the basis of quite accurate assessment indicators and details in the form of credits, weights and/or itemized criteria and result in assessment scores enabling recognizing if the building/facility/urban development/area could be categorized as fulfilling of environmental sustainability requirements or not, partially or completely, in addition to the submission of special recommendations providing the capability of setting up an integrated usable assessment system which could be utilized by experts and competent.

The research methodology for obtaining the afore-mentioned list is based on certain aspects as pointed out below:

- Comprehensive and thorough study of the main active international assessment systems and criteria.
- Studies for certain researches, theses, books, and papers related to the aspect of assessment and evaluation.
- Inspection of sustainability-related consultancy & construction professional work.

The three above-mentioned items work altogether to determine the rating/evaluation factors & indicators of the engineering project items and components. Furthermore, this research adopts a methodology which takes into consideration local recognition in terms of social & climatic environment and geographical factors.

At the end, this research reaches the formation of the generic framework which merge both basic/primary and secondary indicators for the purpose of issuance of a local assessment & rating system. Such indicators could be expanded to embedding the building entire life cycle.

## Life-cycle carbon optimisation in retrofitting under future conditions. A case study in the Mediterranean climate

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### **Biography:**

*Architect (ETSAB), MS in Sustainable Intervention in the Built Environment and currently pursuing a PhD in Architecture, Energy, and Environment (UPC) through an Industrial PhD program in collaboration with Cíclica Arquitectura. Her research and professional activities focus on energy-efficient and ecological building rehabilitation, urban regeneration, and citizen-driven energy transition initiatives.*

Facing the climate emergency, the European Union has committed to reduce greenhouse gas emissions by 55% by 2030 compared to 1990 levels, aiming to achieve climate neutrality by 2050. To meet these targets in the building sector, energy retrofit strategies must address Whole Life-Cycle carbon (WLC) emissions in existing buildings.

However, WLC emission reductions depend not only on the type of intervention in each specific building, but also on future climate overheating scenarios (COS) and electricity emission factors (EEF), both of which can influence the prioritisation of retrofit actions. In Spain, although some strategies and actions have adopted a WLC-based approach, future COS and EEF are still not considered in most cases.

Therefore, based on a previously tested methodology that seeks to reduce WLC emissions in existing buildings, this study aims to determine whether currently and commonly proposed retrofit strategies remain valid, require adjustment, or become counterproductive when COS and EEF are considered. It also assesses whether the selected case study meets the European decarbonisation targets.

The methodology identifies passive intervention combinations that maximise WLC emission reduction using the optimisation tool integrated in DesignBuilder (EnergyPlus) and compares various COS and EEF scenarios. A limited set of intervention options is defined for each building component, based on technical constraints and typical retrofit practices in Spain, considering variations in material types and thicknesses. This methodology is applied to a case study in the Mediterranean climate (Barcelona).

For each scenario, results are presented graphically as point clouds and a Pareto Front curve is defined to identify the most suitable intervention combinations.

Under the analysed future conditions, results indicate that future COS slightly increases annual operational carbon (OC), whereas EEF evolution significantly reduces it. Also, the intervention's embodied carbon (EC) is so considerable compared to OC savings that it would not be compensated over the building's lifetime, thus becoming counterproductive.

In conclusion, if the retrofitting of existing buildings is understood not only as a strategy for mitigating emissions but also as an essential action for adaptation to climate change, it becomes necessary to rethink interventions and prioritise low-EC materials to better address future scenarios.

## Long-term testing of the En-ActivETICS - directions for the development of the novel ActiVer system

Dr Anna Wieprzkowicz<sup>1</sup>, Dariusz Czarny<sup>2</sup>, Prof. Dariusz Heim<sup>1</sup>, Dr Dominika Knera<sup>1</sup>, Michał Krempski-Smejda<sup>1</sup>

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### **Biography:**

*Anna Wieprzkowicz works as an assistant professor at the Faculty of Process and Environmental Engineering. Her main research topic is the use of phase change materials and energy efficiency of buildings, which was the subject of four international research projects in which she participated. She is a member of IBPSA.*

### Introduction

In recent years, solutions that improve photovoltaic efficiency by reducing PV module overheating have gained increasing importance. One of the tested approaches was the En-ActivETICS system, which combines flexible photovoltaic panels with a layer of phase change material (PCM). The PCM was used to stabilize the modules' operating temperature and thus improve their energy efficiency. The purpose of this paper is to present the results of a long-term analysis of the En-ActivETICS system, identify its limitations, and present the concept of a new solution - ActiVer - being developed as part of a subsequent research and development project.

### Methodology

This article presents the results of annual measurements performed under real-world operating conditions of the En-ActivETICS system. The thermal parameters of the panels were measured, including the impact of PCM on module temperature reduction under variable weather conditions. The analysis concerns long term measurement data. Temperature of the panels with and without a PCM layer were compared to wall covered with a traditional ETICS system, painted black. Key weaknesses of the system were identified, and directions for future modifications were identified.

### Results and Discussion

Extreme temperature values for panels without PCM layer exceeded acceptable limits, necessitating the use of a panel cooling strategy. The use of a PCM layer allowed for periodic reductions in the operating temperature of the PV modules, potentially resulting in improved efficiency. However, significant limitations were revealed: the high cost of the PCM material, difficulties with prefabrication, and issues with long-term system durability. These limitations significantly impacted the cost-effectiveness and scalability of the solution, despite the energy benefits achieved.

### Conclusion

Based on experience with the En-ActivETICS, a new concept - ActiVer was formulated. The design eliminates the use of PCM in favour of lightweight, prefabricated perlite-based boards with naturally ventilated air channels. This solution is intended to enable passive cooling of PV modules through convective airflow while maintaining low weight, high stiffness, and ease of installation. ActiVer is expected to eliminate the main weaknesses of the previous system while providing effective thermal control, paving the way for more economical and sustainable implementation in construction practice.

## Low-Carbon Geopolymer Concrete for Construction Industry Decarbonisation Using Red Mud and Recycled Aggregates

Zaid Alnessir<sup>1</sup>, A/Prof Martin Anda<sup>1</sup>

<sup>1</sup>Murdoch University, Department of Engineering and Energy , , Australia

The construction industry is under increasing pressure to reduce its environmental footprint, particularly by minimizing reliance on energy-intensive Portland cement. This research explores the development of sustainable geopolymer concrete using co-calcined red mud and kaolinite as aluminosilicate precursors, combined with recycled construction aggregates. The study addresses the potential of utilizing bauxite residue (red mud), an industrial by-product with low inherent reactivity, by thermally enhancing its structure through co-calcination with kaolinite.

Kaolinite was calcined at various temperatures and durations to identify optimal conditions for metakaolin formation, with 750 °C for 90 minutes producing the most amorphous and reactive phase. Co-calcination of kaolinite with red mud was then conducted across six blend ratios (0–100% RM). Fourier-transform infrared spectroscopy (FTIR) confirmed phase transformations, and binary alkaline activator composed of 8 M sodium hydroxide and sodium silicate (SS:SH ratio of 2.3:1) was used to produce binder pastes using small-scale binder samples tested for 7-day compressive strength to evaluate performance.

The best performing binder condition were recreated in full-scale concrete samples by incorporating recycled aggregates into the mix. Aggregates were characterized for particle size and moisture content, and mix designs were adjusted to SSD conditions.

The 50:50 and 70:30 kaolinite-to-red mud blends exhibited optimal early-age strength, validating the role of co-calcined precursors in producing effective geopolymer binders. Pre-treatment of red mud and oven curing showed improvement in the consistency and strength outcomes.

Despite a significant 60% drop in strength after adding recycled aggregates, the resulting full-scale samples achieved compressive strengths up to 12 MPa at just 7-days curing, allowing for use in some non-load bearing elements.

The results suggest the suitability of valorising red mud and recycled aggregate into non-load bearing components -primary hollow bricks- using over 75% waste materials by weight. Paving a viable pathway of reusing industrial and construction waste, while decreasing the energy cost associated with cement production.

Further research required to assess the long-term strength, durability, and leaching of hollow bricks made using the promoted mix design. Additionally, life cycle assessment could be done after finalizing the product to better understand its environmental impact.

## Low-Grade-Heat Geothermal Applications in Western Australia

Prof Hui Tong Chua<sup>1</sup>

<sup>1</sup>The University Of Western Australia, Crawley, 6009

**Biography:**

*Professor Hui Tong Chua is Professor of Chemical Engineering at UWA.*

*One of his achievements is his catalytic methane cracking technology, known as the Hazer Process.*

*He is a Non-Executive Director of Good Water Energy Ltd., focussing on the baseload geothermal energy for green hydrogen and sustainable aviation fuel production.*

This talk will cover the low-grade-heat geothermal applications in Western Australia, and will focus on ground source heat pumps and outdoor swimming pool heating. In the first part of the talk, the performance of a ground source heat pump (GSHP) is compared with that of an air source heat pump (ASHP) for domestic applications. The outcomes of this comparison are based on a two-year monitoring of each of those systems installed in two near identical adjacent houses in Perth, Western Australia. For heating, the GSHP had an average COP of 3.9, independent of outdoor temperatures, while the COP of the ASHP was in a range of 1.9 to 2.9. Likewise, for cooling, the GSHP had an average COP of 3.1 while the COP of the ASHP varied between 1.3 and 2.8. It is concluded that if a borewell is a part of a dwelling, GSHPs result in considerable operating cost savings and a substantial reduction in greenhouse gas emissions. The second part of the talk is devoted to the thermal performance assessment of geothermal-heated outdoor swimming pools. Such swimming pools are popular in Western Australia. However standard sizing models are typically inadequate in designing for their heating capacities. Our first-principle and analytical model has been calibrated against data from an Olympic sized swimming pool in Perth, Australia. A comparison between various models in the literature shows that our model is able to replicate experimental data much more closely than others, in terms of actual measured pool temperatures and measured heating capacities.

## Machine learning platform, Internal and External Melt Ice Thermal Energy Storage System predictive model

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### **Biography:**

*Olaosebikan Fawas is a Mechanical Engineering postgraduate and Olumuyiwa Yinus Odufuwa, a Senior Lecturer, Dept. of Mechanical & Mechatronic Engineering, Central University of Technology, Free State, South Africa. Research interests include energy management, ice thermal energy storage, solar-HVAC systems, renewable energy and cooling technologies, and applied artificial intelligence.*

Internal melt or external melt Ice Thermal Energy Storage (ITES) configurations are a decisive choice in HVAC efficiency but dynamic in response to demand and weather. This addresses this by developing a predictive optimization platform to ascertain the optimal configuration under defined operating conditions. Comparative analysis was carried out through a simulation-based methodology. Both ITES systems were simulated. They possessed strong data on cooling loads, weather data, and system behaviour. They carried out training for Artificial Neural Networks (ANNs) in order to predict the major parameters like State of Charge (SoC) and energy consumption. The hybrid ANN model was tasked with minimizing energy cost as well as maximizing efficiency. The model's ability to achieve high forecast accuracy was considered. The optimum solutions showed a strong performance disparity: the external melt design was more efficient in discharging for flat, high-demand loads, and the internal melt design was more flexible and economical in highly fluctuating demand conditions because of its more stable outlet temperature. The research gives a fact-based design methodology for ITES selection and illustrates how the best design is very load profile-sensitive. Experimental verification with real data and generalization to include real-time electricity prices will be included in future work.

# MATERIAL PERFORMANCE OF HEMP INSULATION UNDER EXTREME CLIMATIC CONDITIONS IN MINING CAMPS OF WESTERN AUSTRALIA

Mr Piumal Amarakoon<sup>1</sup>

<sup>1</sup>School of Engineering and Energy, Murdoch University, Perth, Australia

## **Biography:**

*I graduated in Mechanical Engineering from the University of Manchester in 2020 and gained five years of industry experience as a mechanical engineer in construction. In 2024, I began my Master's in Renewable and Sustainable Energy Management at Murdoch University, aiming to contribute effectively to the research stream*

Thermal insulation is central to reducing energy demand in buildings and has become increasingly important as industries transition toward sustainable construction practices. Material selection depends on building type and function, with key factors including durability, efficiency, and cost. In Western Australia's mining sector, portable accommodation facilities are widely deployed, yet they face significant challenges to thermal comfort and energy efficiency from extreme climatic conditions. These circumstances present opportunities to introduce sustainable insulation materials that combine thermal performance with cost-effectiveness.

Hemp-based insulation has emerged as a promising alternative due to its lightweight properties, low embodied energy, and financial viability. Despite its growing use in the building sector, limited research has addressed its long-term performance under real climatic stressors, particularly in hot and arid environments. This study investigates the thermal performance of hemp insulation under simulated summer and winter conditions, evaluating the Pilbara region, with specific reference to the West Angelas mining site. Since insulation is typically enclosed in the wall cavity, the study focuses exclusively on temperature-related performance rather than moisture effects.

Two experimental chambers were constructed to evaluate performance: a heat box replicating extreme summer temperatures and a cold box to simulate winter conditions.

Temperature profiles were developed from NASA climate datasets corresponding to the hottest and coldest days of 2024 in West Angelas. Hemp insulation samples were exposed to controlled seasonal conditions for three months, reflecting the region's average duration of extreme temperature cycles. Baseline thermal properties were measured before exposure, including conductivity, resistance, specific heat capacity, heat flux, and heat absorption. After exposure, these properties were evaluated, and a microscopy analysis was carried out to detect microstructural changes.

This work addresses a critical research gap by examining the durability of hemp insulation under realistic temperature conditions. The outcomes provide valuable insights into the suitability of hemp as a sustainable insulation material for portable mining accommodation, with broader implications for developing energy-efficient, climate-resilient, and cost-effective construction practices. Beyond the mining sector, the findings may inform insulation choices for modular housing, remote community infrastructure, and temporary disaster-relief shelters, where lightweight and sustainable solutions are increasingly essential.

## Measuring Electricity Infrastructure Resilience: A Comparative Review of Reliability and Resilience Metrics.

Mr Donald Azuatalam<sup>1</sup>, Mr Alex Shreeve<sup>1</sup>, Prof. Rosemary Lyster<sup>1</sup>, Prof Gregor Verbic<sup>1</sup>

<sup>1</sup>University Of Sydney, , Australia

### **Biography:**

*Donald Azuatalam is a Research Associate at the Centre for Future Energy Networks, School of Electrical and Computer Engineering, University of Sydney, Australia. His research interests include grid integration of renewable energy systems, energy management of distributed energy resources, energy resilience, distribution network cost allocation, and building energy modelling.*

A key technical insight of this research is the distinction between reliability and resilience in how system performance is measured. Traditional reliability metrics—such as the frequency and duration of outages—do not fully capture a system’s ability to withstand and recover from major shocks. Currently, there is no standardised set of resilience metrics widely adopted in Australia’s energy sector to evaluate how well the grid can cope with extreme events. This lack of standardisation makes it difficult to quantify the benefits of infrastructure hardening or to set engineering targets for post-disaster recovery times. The absence of clear metrics and evaluation criteria for resilience at the technical level has introduced uncertainty into the planning process—for both regulators assessing proposals and engineers designing upgrades. Developing common metrics would enable more transparent assessments of resilience improvements and help advance projects that strengthen the grid’s robustness.

## Microwave Processed Graphene Compositions for Energy Storage Applications

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### **Biography:**

*The author of this abstract, currently Professor of Physics and Dean at IIT Patna, has 25 years of teaching and research experience in experimental condensed matter physics focused on renewable energy. He has 150+ international publications, 10 patents, product developments, 4000+ citations, and an h-index of 40 (Scopus).*

The global need for zero-emission energy storage has driven R&D toward cells with high energy density, fast charging, long life, and improved safety. Carbonaceous anodes, including graphitic carbon, carbon nanotubes, and graphene, are commercially utilized but face significant challenges regarding easier, faster, and more cost-effective processing. This research reports a novel process for heteroatom doping in graphene to address these specific manufacturing hurdles.

The process involves preparing a mixture of graphene and a doping precursor (elemental nitrogen, elemental boron, or a combination) in a solvent. This mixture is sonicated to create a dispersed solution, which is then exposed to microwave radiation for 10 seconds to 2 minutes, repeated 8 to 20 times. This method yields one or more layers of heteroatom-doped graphene, resulting in three stable phases of doped graphene.

The doping process successfully generates electrochemically active sites and expands the inter-layer distance to approximately 6Å. The reported approach achieves a tunable, high level of doping, excellent electronic mobility, and sustainable volume changes suitable for energy applications. Electrochemical cells fabricated using this material showed excellent reversibility and rate capability over extended cycles for both Li<sup>+</sup> and Na<sup>+</sup> ion cells. Crucially, the results demonstrate that this material resolves the traditional issues graphitic carbon anodes face in Na<sup>+</sup> ion cells.

The optimized microwave synthesis of graphene provides a universal approach for the large-scale production of 2D materials. This development is positioned to fuel future advancements in energy storage technologies.

## Microwave-Assisted Heterogeneous Catalysis for Butyl Butyrate Production

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### **Biography:**

*I am Shariq Farhan Elahi, a collaborative PhD scholar of IIT (ISM) Dhanbad, India, and Curtin University, Australia. I have received a B.Tech from Aligarh Muslim University, UP, India, and an M.Tech from IIT Ropar, Punjab, India. Currently, I am working on catalysis for sustainable aviation fuel production.*

Biomass-derived sustainable aviation fuel (SAF), such as butyl butyrate, is attracting strong interest for lowering fossil dependence and enabling near-carbon-neutral operation. This study paves a path towards microwave-assisted esterification of butyric acid with n-butanol using functionalized graphene oxide (GO) as a solid acid catalyst. The catalysts were prepared from carbon sources, graphite flakes, and characterized by PXRD, Raman, FTIR, FE-SEM, and HR-TEM. The analyses confirmed successful functionalization of GO, enhanced acidity, and no appreciable changes to GO morphology. Reaction process parameters such as catalyst amount, reaction temperature, and time were systematically optimized. At optimum catalytic reaction conditions, a maximum butyric acid conversion of 94%, with corresponding butyl butyrate yields of 92% was achieved. Under optimized conditions, the reaction followed a Langmuir-Hinshelwood-Hougen-Watson mechanism with pseudo-first-order behavior, giving an activation energy of  $\sim 33 \text{ kJ}\cdot\text{mol}^{-1}$  and thermodynamic parameters  $\Delta G^* \sim -108 \text{ kJ}\cdot\text{mol}^{-1}$ ,  $\Delta H^* \sim 30 \text{ kJ}\cdot\text{mol}^{-1}$ , and  $\Delta S^* \sim -197 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$ . Overall, this work establishes a simple microwave-intensified catalytic route to butyl butyrate and outlines a framework that could be extended to synthesize bio-aviation fuel for future aerospace applications.

## Microwave-Assisted Synthesis of P/O-Doped Graphitic Carbon for Energy Storage Applications

**Prof Yongjin Chung<sup>1</sup>**

<sup>1</sup>Korea National University Of Transportation, Chungju, Korea

**Biography:**

*Professor Yongjin Chung leads the Energy Materials Lab at Korea National University of Transportation, advancing next-generation batteries and carbon materials. His team pioneers microwave-synthesized, heteroatom-doped carbons for lithium ion batteries, sodium ion batteries, supercapacitors and vanadium redox flow batteries.*

P-doped, O-rich graphitic carbon (POGC) was synthesized via an environmentally friendly, cost-effective microwave-assisted (MW) treatment using phytic acid as the precursor. MW irradiation promoted the formation of coral-like clusters and barrel-like graphitic structures, with both the extent of P-doped graphitic domains and the prevalence of P–C bonds increasing with irradiation time. The higher degree of graphitization enhanced electrical conductivity and catalytic activity toward the vanadium-ion redox reactions (VIRRs). An optimal irradiation time of 60 s (POGC-60) was identified from cyclic voltammetry of the VIRRs: POGC-60 exhibited the highest peak current densities in both anolyte and catholyte, approximately threefold higher than the control electrode, and it markedly reduced the charge-transfer resistance, indicating a lower VIRR overpotential. Similar improvements—higher peak currents, smaller peak-to-peak separations, and lower charge-transfer resistance—were obtained when POGC was integrated with commercial graphite felt (GF) to form GF/POGC electrodes. Vanadium redox-flow batteries (VRFBs) employing GF/POGC delivered higher efficiencies and discharge capacities (even at high current densities) together with excellent long-cycle stability. Overall, these results establish MW irradiation as a commercially viable route for the rapid, cost-effective, and environmentally benign production of high-performance VRFB catalysts.

## Minimizing Vibrations in the SRM-Driven Solar Water Pump

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### **Biography:**

*Ruchao Pupadubsin received the Ph.D. degree in*

*electrical engineering from Newcastle University,*

*Newcastle upon Tyne, U.K., in 2018. He is currently*

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*Technology Center, Pathum Thani, Thailand.*

*His research interests include electrical machine design/drive system, acoustic noise and vibration in electrical machines analysis.*

Solar-powered water pumps are the most effective way to take advantage of the plentiful solar power available. The crucial nature of water pumping applications necessitates the use of a durable, highly reliable, cost-effective, high-starting torque, and efficient motor drive.

Switched Reluctance Motors (SRMs) are widely recognized for their high efficiency and exceptional durability, characterized by a straightforward design where windings are exclusively located on the stator, with no permanent magnets or windings on the rotor. This inherent simplicity allows SRMs to operate effectively at elevated temperatures and they demonstrate robustness against short circuits in individual phases. These benefits make the SRMs one of the most suitable motors for use in rural areas such as water pump applications. Despite these significant advantages, a primary challenge associated with SRMs is the considerable noise and vibration they generate. This issue largely stems from their intrinsic structural characteristics and the control methods employed, particularly due to high radial magnetic force during the turn-off angle of current supply. Consequently, the lifespan of the pump and its parts, including the bearing and sealing mechanism, can be considerably shortened by excessive vibration. Furthermore, vibration can disperse energy, diminishing pump efficiency and raising operating and maintenance expenses. To overcome these existing limitations, a proposed PWM switching pattern has been developed for SRMs.

The proposed technique is simple to implement, requires no structural modifications or motor mechanical data, and is compatible with all PWM-based control methods. It utilizes a specific varying PWM duty ratio for two power switches, enabling three-level phase voltage states: +V<sub>ph</sub>, 0V, and -V<sub>ph</sub> during the PWM switching period.

Simulation results demonstrate its effectiveness, and a vibration reduction of up to 62% (from 106.03 m/s<sup>2</sup> to 40.10 m/s<sup>2</sup>) was achieved compared to the conventional control method, while maintaining torque efficiency.

In summary, the proposed technique offers a practical, effective, and easily applicable solution to the long-standing problem of vibration in SRMs. By significantly reducing vibration while maintaining or even improving torque efficiency, and without requiring structural modifications or motor-specific

data, this proposed method has the potential to expand the operating lifetime of solar water pumping applications.

## Mixed Modulation and Dead-Time Compensation for Enhanced AC Voltage Quality in Single-Phase Sine-Wave Inverters

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<sup>1</sup>National Electronics and Computer Technology Center (NECTEC), Pathum Thani, Thailand

### **Biography:**

*Dr. Surasak Nuilers received his B.S. and M.S. degrees in Electrical Engineering from KMUTNB, Thailand, in 2008 and 2010, and his Ph.D. from the Tokyo Institute of Technology, Japan, in 2022. He is currently a Researcher at NECTEC, Thailand, with research interests in power conversion systems for renewable energy applications.*

A standalone power system (SPS) is essential for remote areas without access to the utility grid. In such systems, photovoltaic (PV) panels act as the primary energy source, supplying power to a DC/AC or sine-wave inverter (SWI), while surplus energy is stored in a battery energy storage system (BESS). The SWI plays a critical role in delivering high-quality sinusoidal voltage to end-user loads.

The SWI initially generates an AC voltage containing high-frequency harmonics, which are attenuated by an LC filter at the AC side. Typically, unipolar or bipolar pulse-width modulation (PWM) with a high switching frequency is employed to synthesize the AC voltage. However, dead-time (DT) insertion, required to prevent shoot-through in each inverter leg, introduces output voltage distortion. This distortion becomes more pronounced near the zero-crossing point, where PWM errors may cause certain pulses to disappear, significantly degrading voltage quality. To mitigate these effects, a bulky LC filter is often required, increasing both the size and cost of the SWI while limiting system optimization.

This paper proposes a combined mixed modulation and DT compensation strategy to reduce SWI output distortion, especially during zero-crossing intervals. The mixed modulation approach combines unipolar and bipolar PWM techniques. Unipolar modulation is applied when the output current exceeds a critical current, allowing switching devices to operate in hard-switching region. Conversely, bipolar modulation is employed inside the zero-voltage switching (ZVS) region. The critical current is analytically derived and serves as a key threshold for selecting the appropriate modulation method. This adaptive strategy significantly improves waveform quality near zero-crossing points. Furthermore, a DT compensation technique is integrated into the PWM scheme to address distortion in other regions of operation.

A 3-kW, 20-kHz, single-phase SWI with a 3- $\mu$ s DT and a compact LC filter (1 mH and 6  $\mu$ F) is simulated in PSIM to validate the proposed method. The simulation results show that the proposed approach reduces the total harmonic distortion of the output voltage (THD<sub>v</sub>) to 3.5%, compared to 9.21% with conventional unipolar PWM and 6.19% with conventional bipolar PWM, while allowing the use of a smaller LC filter to minimize system size and cost.

## Modelling Long-Duration Energy Storage Options for Renewable Grids Under Climate Uncertainty

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<sup>1</sup>University Of Canterbury, Christchurch, New Zealand, <sup>2</sup>University Of Auckland, Auckland, New Zealand

### **Biography:**

*Madison Zegeer is a PhD Candidate at the University of Canterbury with the Sustainable Energy Research Group (SERG). Her research focuses on stochastic modelling and integrating climate uncertainty into capacity expansion models to support robust energy planning. She holds a BSc in Physics and a Master's in Renewable Energy Engineering.*

Hydro-dominated energy systems, such as New Zealand's, offer unique flexibility by providing both generation and storage capacity. However, these systems are inherently vulnerable to hydrological variability and increasingly stressed by climate change. Historically, thermal generation has helped buffer this variability, but with the urgent need for defossilisation, alternative storage solutions must be explored. While Stochastic Dual Dynamic Programming (SDDP) remains the benchmark for long-term hydropower operational planning, its computational intensity limits its use in high-resolution capacity expansion models (CEMs), the primary tools for guiding investment and operational decisions under defossilisation pathways. Additionally, many CEMs rely on perfect foresight assumptions, which can misrepresent hydropower's operational flexibility.

To address these challenges, this ongoing research proposes a modelling framework that is a reduced-order stochastic approach. At its core is GEMSTONE, a two-stage stochastic capacity expansion model designed to capture hydropower variability using a set of representative inflow years. GEMSTONE derives a simplified hydropower operating policies, represented as seasonal reservoir release "gates" across major catchments. To ensure these policies are both realistic and robust, the gates are calibrated against outputs from JADE—a fully resolved, high-fidelity SDDP model that simulates detailed hydropower operations under uncertainty.

Results show that GEMSTONE's calibrated gates closely approximate the operational patterns produced by JADE. Applied to a range of generation and storage scenarios for New Zealand in a 2025 reference year, GEMSTONE effectively captures key features of interannual hydro variability while maintaining computational efficiency. Operational costs and dispatch patterns, especially during critical dry years, show strong alignment between the models. However, GEMSTONE slightly underestimates flexibility in extreme dry conditions due to its simplified short-term representation.

Ongoing work is extending the framework by incorporating new hydrological years based on Representative Concentration Pathways (RCPs) to better reflect future climate uncertainty. As a next step, the calibrated reservoir release gates are being embedded into REMix-NZ, a high-resolution deterministic CEM. This integration offers a practical pathway for embedding hydrological uncertainty into deterministic planning tools. This is an important advancement as hydropower's role becomes increasingly vital in supporting defossilisation, grid reliability, and its interaction with emerging storage technologies such as hydrogen.

## Molecular Design of Crown Ethers and Calixarenes for Selective Metal Extraction

Dr Mikio Ouchi<sup>1</sup>, Dr Tanjina Sharnin<sup>1</sup>, Dr Kouji Maeda<sup>2</sup>, Dr Kenji Mishima<sup>1</sup>, Dr Mauro Mocerino<sup>3</sup>

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### **Biography:**

*Dr. Mikio Ouchi is visiting professor at Research Institute of Composite Materials, Fukuoka University. He is emeritus professor at University of Hyogo. His research is based on synthetic organic chemistry in the field of supramolecular chemistry. He is network coordinator of Australia-Japan Network for Energy Transition and Critical Materials.*

### Introduction:

As part of the Australia–Japan Network for Energy Transition and Critical Materials, our research explores how molecular design can deliver more effective and selective extractants for critical metals. Macrocyclic compounds such as crown ethers and calixarenes have long attracted interest in their ability to recognize and bind cations, but systematic studies of their selectivity in extraction remain essential. In this work, we examined how structural modifications influence their cation binding properties with the goal of developing selective metal extraction.

### Methodology:

Crown ethers were synthesized by Williamson ether synthesis, while calixarenes were prepared by condensation of p-substituted phenols with formaldehyde. The compounds were purified by recrystallization or distillation under reduced pressure and characterized using <sup>1</sup>H NMR, IR, MS, and elemental analysis. Their extraction performance was evaluated by solvent extraction of metal picrates in water–dichloromethane systems, and extraction equilibrium constants (*K<sub>ex</sub>*) were determined to assess binding efficiency and selectivity.

### Results and Discussion:

Both crown ethers and calixarene derivatives acted as effective cation extractants, with selectivity governed by ring size, ion–dipole forces, and cation– $\pi$  interactions. Substituents and lariat modifications enhanced selectivity toward sodium, silver, and thallium ions. Oxygen donor atoms in calixarenes favored alkali metal binding, while structural adjustments provided fine control over selectivity. Interestingly, there are very few reported examples of thallium(I) complexation with crown ethers and calixarenes, making our results a valuable addition to the field.

### Conclusion:

By adjusting the structures of crown ethers and calixarenes, we have shown how molecular design can directly influence cation recognition. The comprehensive solvent extraction data we present point out not only to new opportunities in solvent extraction but also to possible applications in membrane transport. This work highlights how smartly designed macrocyclic compounds can support the sustainable recovery of critical metals.

## Multi-criteria decision analysis for low-carbon rural electrification in Indonesia

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<sup>1</sup>University Of Auckland, Auckland City, New Zealand

### *Biography:*

*Annisa is an energy and sustainability consultant from Indonesia with a prior research background on geothermal exploration & direct-use and rural electrification strategy.*

*Bart van Campen serves as the Programme Director for the MEnergy program at the University of Auckland, an interdisciplinary energy program from various engineering and commerce backgrounds.*

Unreliable electricity plagues rural Indonesian communities, leaving 1.3 million households reliant on polluting diesel generators. While the government targets universal access by 2030, it must prioritise low-carbon, reliable and sustainable solutions. Yet national top-down planning often sidelines local voices and stalls projects. To address this challenge, we develop a multi-criteria, scenario-based framework to assess electrification technologies under various transition scenarios.

We characterise rural areas via electrification metrics and select three remote rural electrification case studies—Mentawai Islands, Kotawaringin Timur, and Manokwari Selatan. Our framework uses 12 indicators framed by the energy trilemma (equity, security, environmental sustainability), techno-economic modelling in HOMER Pro, and Analytical Hierarchy Process (AHP) as the selected multi-criteria decision analysis method. Candidate technologies are ranked and assessed under three scenarios from the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) 2050: Current Policy (CPOS), Transition Scenario (TRNS), and Low-Carbon Paris-Compatible Path (LCCP), each emphasising different indicator aspects: equity in CPOS, environmental sustainability in LCCP and balance in TRNS. We calculate composite performance scores and conduct sensitivity analyses.

Results reveal electrification preferences vary by resources, economic value, and community input—partially matching the national electricity company (PLN)'s solar PV—and storage focus, but diverging when PLN still plans coal and gas turbines to power Kotawaringin Timur and Manokwari Selatan. More importantly, the results show that the preferred technologies vary under different scenario assumptions. For instance, in Kotawaringin Timur, the top choice shifts from micro-hydro–diesel (CPOS) to micro-hydro–biofuel (TRNS), and then to solar PV–battery (LCCP). This highlights the adaptability of the framework. Across all scenarios and weighting variations, however, hybrid renewable-based systems consistently emerge as the highest-performing options, underscoring their robustness and superiority compared with single-technology solutions.

Overall, our framework is flexible and rigorous: it adapts to local data and stakeholder priorities by incorporating their weighting preferences, and presents results in clear, comparable overviews that help PLN, NGOs, and international partners identify optimal solutions. By operationalising the energy trilemma, it supports fair stakeholder input and transparent, locally relevant decision-making.

## Multi-criteria Site Selection for Rural De-dieselization in Indonesia: Integrating AHP and LINMAP

Mrs Eka Nurdiana<sup>1</sup>, Mr Ahmad Gusyairi<sup>1</sup>, Mrs Dannya Maharani Putri Utami<sup>1</sup>, Mrs Adinda Prawitasari<sup>1</sup>, Dr Kholid Akhmad<sup>1</sup>, Mrs Hafsa Halidah<sup>1</sup>, Dr Khotimatul Fauziah<sup>1</sup>, Mrs Suhraeni Syafei<sup>1</sup>, Mr Christian Thessio Hasian Sidauruk<sup>2</sup>, Mr Heri Dwi Sulisty<sup>2</sup>, Prof Tania Urme<sup>3</sup>

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### **Biography:**

*Since 2014, Eka Nurdiana has worked as a researcher. She completed her bachelor's degree in physics at Semarang State University and her master's degree in electrical engineering at the University of Indonesia. Her research interests include photovoltaic (PV) performance, techno-economic analysis, energy efficiency, demand-side management, and multi-criteria decision-making.*

Rural electrification in Indonesia has long depended on isolated diesel generators (DGs). The dispersed geography of the archipelago complicates national grid expansion, while DGs cause persistent problems such as high operating costs, fuel supply disruptions, greenhouse gas emissions, and significant health risks. These issues mirror broader challenges in many developing countries striving for sustainable energy access in remote areas. To reduce reliance on DG, the Indonesian Government launched a de-dieselization initiative, requiring a systematic framework to prioritize the replacement of more than five thousand existing units. This study integrates the analytical hierarchy process (AHP), a multi-criteria decision-making tool and linear programming technique for multidimensional analysis of preference (LINMAP) to establish retirement priorities. The objective is to identify the DG units with the highest priority for replacement with local renewable energy, specifically solar photovoltaic (PV) systems. Technical data from the national utility was analysed in three sequential steps: weighting evaluation criteria, filtering candidate sites, and ranking feasible alternatives. Using the AHP expert pairwise comparisons, produced weights for eleven evaluation criteria, narrowing 34 potential sites to eight. The LINMAP method was applied to perform linear programming on the eight alternatives, with MATLAB used for optimization. Results indicate that solar radiation, cost of energy, and net peak load growth are the most decisive factors. The ranking highlighted three locations as top-priority candidates for DG substitution with PV. This study presents a novel integration of AHP and LINMAP for de-dieselization, applied for the first time in Indonesia. While focusing on technical data and PV-based options, it highlights the need for future research to incorporate socio-economic and environmental factors, hybrid renewable systems, and broader site evaluations. The findings demonstrate that combining multi-criteria decision-making methods strengthens rural electrification planning and supports renewable energy transition strategies.

## Murray Goulburn (MG) Biogas Engine Project - Case Study

Mr Matthew Percival<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

**Biography:**

*Matthew Percival, has over 30 years' experience across industrial, commercial, healthcare, and heritage projects. A PMP and P3 Governance Practitioner, he is a Director of the WA PMI Chapter and has led award-winning sustainable infrastructure initiatives. Matthew is a Senior Project Manager at Murdoch University Campus Development,*

This case study examines the Murray Goulburn (MG) Biogas Engine Project implemented at the Leongatha dairy processing facility in Victoria, which was recognised with the Australian Institute of Project Management (AIPM) Victorian Award for Sustainable Projects in 2010. The project represents a pioneering integration of renewable energy generation within the Australian dairy industry, addressing both environmental and operational challenges.

The initiative involved the installation of two biogas engines with a combined generating capacity of approximately 0.76 MW. These engines utilise methane-rich biogas captured from the plant's wastewater treatment facility (WWTP), converting waste emissions into a valuable energy source. The recovered energy supplies around nine percent of the factory's electricity demand, thereby reducing reliance on grid power and contributing to operational cost savings estimated at AUD \$300,000 annually. The project was delivered at an approximate capital cost of AUD \$1.8 million, with support from Sustainability Victoria.

In terms of technical outcomes, the project successfully demonstrated the integration of anaerobic wastewater treatment by-products with on-site cogeneration. A 440-metre high-voltage transmission link connects the engines directly to the factory, ensuring stable and continuous electricity supply while maintaining uninterrupted operation of the treatment plant. By displacing conventional electricity consumption and capturing methane that would otherwise be released, the project has achieved significant environmental benefits. To date, the facility has generated over 350 MWh of renewable electricity, with potential scalability to meet a greater share of site demand.

From a project management perspective, the MG Biogas Engine Project illustrates the application of sustainability principles to industrial infrastructure delivery. The project embedded environmental, social, and financial considerations consistent with "triple bottom line" evaluation, while meeting strict requirements for continuity of manufacturing operations. This dual emphasis on cost efficiency and environmental stewardship underpinned the award recognition received from AIPM.

In conclusion, the Murray Goulburn Biogas Engine Project provides a robust case study of industrial innovation, demonstrating the feasibility of integrating waste-to-energy systems within food processing. It highlights the potential for replication across similar sectors, offering valuable lessons in sustainable project execution and the strategic alignment of environmental technologies with corporate operations.

## My EV Experience

Mr Walter James<sup>1</sup>

<sup>1</sup>Curtin And Murdoch Universities, Perth, Australia

**Biography:**

*Mechanical Engineer, Researcher, Entrepreneur, CEO several Cos, Retired*

### MY "FLYING CARPET" EV EXPERIENCE

Introduction. The paper highlights the experience of owning an EV in Perth, Australia.

Methodology. It compares the Greenhouse Gas life-cycle of conventional, hybrids and EV and indicates where the market will shift to.

It shows the most practical, least emitting and most economic way of charging the EV and its effects on the grid.

Results and Discussion. It discusses the storage requirements for the EV and home and the options of exporting to the grid as vehicle to grid (V2G). It graphically shows the time effects of a daily load of a residence and how it is affected by solar and storage and its potential for grid exports. It shows graphically the effects on the main grid as well as the wholesale price of electricity. It compares the different battery chemistries available now and in the near future and the expectancy of Sodium ion entering the market.

Conclusion. It shows that the running costs of EV with the right tariff can be as low as 7% of those of an internal combustion and with a lifecycle reduction of emissions of 73%. It shows that V2G can provide ample storage for a stable grid. It highlights the future of Sodium ion for both EV and the grid. It shows the devilish new load profile a nuclear plant would have to contend with making it impossible to operate when solar, wind and battery storage are available.

Finally it shows the practicality and delights of driving a modern EV.

## Net-Zero Pathways in Broadacre Agriculture: Co-Benefits of integrating Biochar, compost and afforestation

Mr Muhammed Atikul Haque<sup>1</sup>, Professor Tania Urmee<sup>2</sup>, Professor Christopher Lund<sup>3</sup>

<sup>1</sup>School of Engineering and Energy, Murdoch University, Perth, Australia, <sup>2</sup>School of Engineering and Energy, Murdoch University, Perth, Australia, <sup>3</sup>School of Engineering and Energy, Murdoch University, Perth, Australia

### **Biography:**

*Muhammed Atikul Haque is a PhD student at Murdoch University researching adaptation and mitigation co-benefits in broadacre farming. With over seven years' experience in research, project management, and climate negotiations, his expertise spans adaptation, Loss and Damage, finance, and migration, reflecting his commitment to fostering climate-resilient communities.*

**Introduction:** This study quantifies the multi-faceted co-benefits associated with biochar, compost and afforestation within broadacre agriculture, thereby explaining actionable pathways for achieving net-zero transitions that harmonize economic, environmental, and social imperatives. Broadacre agricultural practices are increasingly compelled to undertake decarbonization efforts while simultaneously preserving food security and the livelihoods of rural communities. This research examines the extent to which this adoption can optimize co-benefits, mitigate trade-offs, and facilitate sustainable, resilient, and economically viable transitions within the agricultural sector.

**Methodology:** A comprehensive scoping review of the literature published from 2020 to 2025 was undertaken, synthesizing empirical evidence regarding, the combined application of biochar, compost and afforestation and the principles of net-zero in agriculture. The analytical framework explicitly addresses context-dependent trade-offs, technological expenditures, policies, and outcomes related to climate adaptation, mitigation & other socio-environmental benefits leveraging insights from case studies, regional energy assessments, carbon market data, and evaluations of policy efficacy.

**Result and Discussions:** The findings indicate that the adoption of the integrated application of biochar, compost and afforestation confer substantial co-benefits that extend beyond the sole mitigation of greenhouse gas emissions. The combined application of these nature-based solutions enhances soil health, augments crop productivity & increased resilience against climatic shocks. Wider Socio-environmental advantages encompass the enhancement of air and water quality, biodiversity conservation, creation of rural employment opportunities and the advancement of community development. Economic modelling reveals that net-zero pathways surpass conventional business-as-usual scenarios, producing elevated GDP growth rates (8.1% compared to 6.7%) and benefit–cost ratios exceeding 1.04 by 2030, with projections of nearly tripling by 2050. Existing challenges—such as considerable initial investment costs, fragmented policy frameworks, and equity considerations—underscore the necessity for integrated governance mechanisms, innovative financing, and active stakeholder participation.

**Conclusion:** Through the explicit quantification of multi-dimensional co-benefits and trade-offs, this study identifies research gaps within broadacre agriculture. The results elucidate that this integration can function as transformative catalysts for climate mitigation, economic advancement, and social equity. Subsequent research endeavours should prioritize field-level validation, longitudinal monitoring, and contextually tailored governance and financing strategies to facilitate widespread and equitable adoption



## Next-Generation Asset Management for Solar PV Using LiDAR PointCloud, AI-Based Digital Twin & centralized SCADA

Mr Vijith Kartha<sup>1</sup>

<sup>1</sup>rProcess Outsourcing Services Pvt Ltd, Mysore, India

### **Biography:**

*Vijith Kartha is a Senior Engineering Manager at rProcess with 10+ years of experience, delivering 5,200+ energy projects globally across residential, C&I & utility-scale sectors.*

*He specializes in design optimization and leading teams to drive digitalization/automation using AI, geospatial and data-driven solutions for optimal design, asset management and centralized operations.*

### **Introduction**

The rapid growth of large commercial, utility-scale solar PV & battery storage projects has exposed inefficiencies in traditional asset management. Manual site visits, fragmented data, disconnected design, construction & operations teams, and the absence of centralized 24/7 monitoring result in significant time loss, rework, and errors. This study presents a centralized Digital Asset Management (DAM) framework integrating LiDAR-based site intelligence, AI-driven digital twins, and centralized SCADA systems to enhance design accuracy, reduce rework, and enable proactive asset management.

### **Methodology**

The framework combines LiDAR scanning, AI-based point cloud processing and centralized DAM architecture. UAV and terrestrial LiDAR data are processed through AI models for automated classification, annotation and asset extraction. Outputs generate accurate digital twins and BIM-compatible CAD models serving as a single source of truth throughout design, construction and operations. These digital assets integrate with SCADA systems to align physical assets with real-time and historical performance, enabling continuous monitoring, validation and optimization across distributed solar PV and battery storage portfolios.

### **Results and Discussion**

The approach significantly reduces ~43% of time spent on manual inspections, measurements and iterative design corrections. Centralized DAM enabled faster virtual site assessments and early identification of design clashes, terrain constraints and installation deviations, minimizing downstream rework and errors to as much as 30%. Digital twins improved consistency in asset representation, design optimization, design optimization for presales, and compliant-ready detailed engineering design. Accurate as-built and terrain data improved layout efficiency and constructability for both solar and battery systems. SCADA-integrated digital twins provided a unified operational view, enabling rapid fault diagnosis, asset traceability and consistent performance benchmarking. The framework delivers higher accuracy, shorter project cycles and enhanced cross-team coordination, reinforcing emerging research on AI-driven digital twins in renewable energy.

### **Conclusion**

Centralized DAM leveraging LiDAR, AI-based digital twins and SCADA integration can transform solar PV and battery storage lifecycle management. By reducing reliance on manual processes, the framework minimizes time loss, design errors and rework while enabling efficient design and proactive operations. Though initial digital setup requires investment, long-term benefits in

efficiency, accuracy and scalability are significant. Future work may explore predictive maintenance & automated compliance validation

## NH<sub>3</sub> synthesis using an electrochemical membrane cell with molten alkaline electrolytes and Ru Catalysts

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<sup>1</sup>Department of Chemical Engineering, Fukuoka University, Japan,

**Introduction:** NH<sub>3</sub> (NH<sub>3</sub>) has gained increasing attention as a carbon-free energy carrier and potential fuel. However, conventional NH<sub>3</sub> production depends on fossil-derived H<sub>2</sub>(H<sub>2</sub>), resulting in substantial carbon dioxide (CO<sub>2</sub>) emissions. To achieve sustainable synthesis powered by renewable electricity, new electrochemical approaches are required. Similar to the Haber–Bosch process, NH<sub>3</sub> formation at intermediate temperatures is limited by thermodynamic equilibrium, which restricts the single-pass yield. Therefore, continuous removal of produced NH<sub>3</sub> through liquefaction separation and recirculation of unreacted gases is essential to drive the reaction forward. In this study, we developed an integrated electrochemical process to address these equilibrium constraints and enhance the overall synthesis efficiency.

**Methodology:** NH<sub>3</sub> synthesis was conducted from steam and nitrogen (N<sub>2</sub>) at 250°C and 1.0 MPa using molten NaOH–KOH electrolytes, a Pd–Ag H<sub>2</sub>-permeable membrane, and Ru/Cs+/C catalysts. To overcome the equilibrium limitation that restricts single-pass NH<sub>3</sub> yield (~36%) under these synthesis conditions, the system incorporated an NH<sub>3</sub> gas–liquid separator and recirculation of unreacted gases, allowing continuous operation and improved efficiency of electrochemical NH<sub>3</sub> synthesis in the reactor.

**Results and Discussion:** Under optimized operating conditions of 250°C, 1.0 MPa, 100 mA cm<sup>-2</sup>, and N<sub>2</sub> flow of 1.0 mL STP min<sup>-1</sup>, the electrochemical system exhibited an apparent current efficiency of approximately 95% for NH<sub>3</sub> synthesis, with the remaining 5% corresponding to H<sub>2</sub> formation. The cell operated stably for 30 days at a voltage of 1.8 V and a current density of 100 mA cm<sup>-2</sup>, corresponding to a voltage efficiency of 73% and an overall energy efficiency of 69%. At higher current densities (>100 mA cm<sup>-2</sup>), a gradual decline in current efficiency was observed, likely due to cross leakage between the compartments or the limited H<sub>2</sub> absorption capacity of the Pd–Ag membrane under high current densities.

**Conclusion:** This study presents an integrated electrochemical approach for direct NH<sub>3</sub> synthesis from H<sub>2</sub>O and N<sub>2</sub>, offering a promising pathway toward renewable NH<sub>3</sub> production. Future work will focus on enhancing performance under high current density conditions, mitigating cross-leakage and improving H<sub>2</sub> transport in a Pd–Ag membrane, as well as developing non-noble materials and improving long-term stability to enable the practical implementation of this NH<sub>3</sub> synthesis technology.

# Niche Innovations and Energy Justice: Navigating India's Transition to Electric Mobility

Miss Manisha Drall<sup>1,2</sup>, Prof. Pradip Swarnakar<sup>1</sup>, Dr. Malliga Marimuthu<sup>2</sup>, Prof. Clare D'Souza<sup>2</sup>

<sup>1</sup>Indian Institute of Technology Kanpur, Kanpur, India, <sup>2</sup>La Trobe University, BUNDOORA, Australia

## *Biography:*

*Manisha Drall is a joint PhD candidate at the Indian Institute of Technology Kanpur and La Trobe University, Australia. Her research examines India's transition to electric mobility, focusing on socio-technical change and energy justice.*

## Introduction

India's shift from Internal Combustion Engine (ICE) vehicles to Electric Vehicles (EVs) is critical for decarbonizing transport and addressing climate change. The transition supports national goals such as achieving net-zero emissions by 2070, reducing fossil fuel dependence, and promoting cleaner mobility. While EVs promise environmental gains, niche actors face the dual challenge of advancing new technologies and addressing the social and economic disruptions such innovation brings. Yet, despite their potential to drive ecological innovation and influence systemic change, their role in shaping the transition remains rather underexplored. This study examines how niche actors contribute to India's EV transition and what challenges they encounter through the lens of the Multi-Level Perspective (MLP) and the Energy Justice framework, highlighting both socio-technological dynamics and questions of equity and justice.

## Methodology

The study adopts a qualitative approach based on 48 in-depth interviews with auto manufacturers, EV startups, supply chain actors, civil society organisations, and policymakers in India's automotive sector. This paper focuses specifically on niche actors to analyse their role and challenges in the EV transition. Data were collected using a semi-structured questionnaire. Using MLP, it examines the dynamics between niche innovations and existing structures. An Energy Justice lens evaluates equity and inclusion in the opportunities and challenges faced by niche actors.

## Results and Discussion

Findings reveal that niche actors, while driving innovation in India's EV ecosystem, encounter significant barriers to growth and scale. Their impact is restrained by financing constraints, weak brand recognition, lack of infrastructure, fragmented policy support, and exclusion from decision-making spaces dominated by incumbents. Energy justice concerns emerge in unequal subsidy distribution and limited procedural inclusion, highlighting how systemic power imbalances restrict the scaling of socially inclusive solutions.

## Conclusion

By integrating socio-technical transition theory with an energy justice perspective, this study highlights the dual role of niche actors as both innovators and stakeholders constrained by systemic barriers in India's EV transition. Their contributions are vital for advancing socio-economic innovation, yet their struggles highlight the need for supportive policies and collaborative frameworks. Recognising and empowering these actors is essential for achieving a just and sustainable transition toward electric mobility.

## Non-Linear Droop Control Methods for Enhanced Active Power Sharing in Hybrid Microgrid

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<sup>1</sup>Department of Intelligent and Mechanical Interaction Systems, University of Tsukuba, Tsukuba, Japan

### **Biography:**

*Khisa Sirengo has a B.Sc. degree in Mechatronic Engineering, an M.Sc. degree in Information Technology, and Mechanical Systems from Ashikaga University, Japan. His research interests are power systems, inverters, and distributed generation. He is currently a doctoral candidate at the University of Tsukuba, Japan.*

### **Introduction:**

The integration of power-electronic-based inverters and conventional synchronous generators in a parallel-operated microgrid presents a significant challenge in maintaining effective transient load sharing. The inherent mismatch in dynamics—where fast-acting inverters lack the inertial stability of slower rotating generators—can lead to frequency excursions and poor damping during load disturbances.

### **Methodology:**

This research proposes a non-linear droop control strategy to address this challenge by leveraging the distinct dynamic characteristics of both power sources. The method provides a non-linear relationship between active power and frequency in the inverter. By carefully tuning the hyperparameters, the inverter's sensitivity to frequency changes can be precisely modulated. We successfully designed non-linear droop hyperparameters to maintain a dynamic but monotonic droop characteristic that is highly responsive in the inverter's critical operating range. We define important operation zones: the high-gain zone and the low-gain zone-2. The high-gain zone aggressively offers support to the grid because frequency is allowed to drop more to inject more power into the grid. In low-gain zone-2 protects the inverter hardware from overloading. The inverter response is made conservative to reduce the rate of power injection while remaining safe online at its maximum output even as the frequency drops further.

### **Results:**

Preliminary results confirmed that compared to linear droop control, the non-linear controlled inverter quickly absorbs transient loads and ensures smooth and stable load sharing. Suitability in hybrid microgrids was further confirmed by analyzing the dynamic performance. Simulation results demonstrate that non-linear droop control significantly enhances the microgrid's transient load response.

### **Conclusion:**

The proposed method overcomes the challenges of linear droop by a dynamic non-linear droop gain that alternates between conservative response and aggressive support depending on the frequency. Further analysis of the dynamic performance of the non-linear droop confirms that its secondary characteristics can be used to improve synchronizing stiffness, damping term, and response time, which is not possible with the conventional linear droop.

## Numerical and Flume Validation of a 1 kW Shore-Based Wave Energy Converter

Dr Yu-Jung Lee<sup>1</sup>, Professor Dong-Jiing Doong<sup>2</sup>, Professor Chih-Min Hsieh<sup>3</sup>, Dr. Yu-Jen Chen<sup>1</sup>, Dr Jing-Hua Lin<sup>2</sup>, Dr. Yang-Ming Fan<sup>2</sup>, Professor Shih-Chun Hsiao<sup>2</sup>

<sup>1</sup>Southern Taiwan University of Science and Technology, Tainan, Taiwan, <sup>2</sup>National Cheng Kung University, Tainan, Taiwan, <sup>3</sup>National Kaohsiung University of Science and Technology, Kaohsiung, Taiwan

### **Biography:**

*Dr. Yu-Jung Lee, Assistant Professor at the Department of Mechanical Engineering, Southern Taiwan University of Science and Technology. Her expertise includes mechanism design, optical measurement, vibration and noise analysis, with extensive experience in theoretical mechanics modeling and system integration.*

Most wave energy studies emphasize hydrodynamic performance, which plays a major role in overall efficiency; however, few examine the complete conversion chain to electrical power. Understanding how energy is distributed and dissipated across subsystems is essential for improving system performance. This study presents a 1 kW shore-based wave energy converter, designed and validated as a platform for detailed efficiency analysis and subsystem optimization.

The experimental system was constructed at a 1:3 scale to reduce the influence of non-scalable mechatronic components. It is composed of a buoy with 2 m characteristic width, a 4 m oscillating arm, a hydraulic power take-off, a disk-type axial flux permanent magnet generator, and a three-phase rectifier supplying DC power. A SCADA system was also developed to integrate sensors for hydraulic pressure and flow, torque, and rotational speed, enabling monitoring of energy transfer from wave excitation to rectified output.

Numerical simulations were conducted in MATLAB/Simulink using hydrodynamic response data from ANSYS AQWA. To validate these predictions, physical tests were carried out in a large flume tank. Power and efficiency matrices were established under regular and irregular waves. The device achieved a peak overall efficiency of 19.4% in regular waves at a wave height of 0.31 m and a period of 2.38 s, with subsystem efficiencies of 38.7% (hydrodynamic), 73.0% (hydraulic PTO), and 68.6% (generator). Under irregular waves, overall efficiency reached up to 9.8%. Experimental results showed good agreement with numerical predictions, supporting estimation to broader conditions beyond flume limitations.

The findings confirm the feasibility of the prototype and show that the complete power flow from waves to electricity can be experimentally traced. With the support of the SCADA system, subsystem performance could be monitored in detail, allowing both overall efficiency and internal losses to be evaluated. Although subject to scale effects and wave-generation limitations in the flume tank, the tests and simulation were able to describe the key performance characteristics of the prototype. This work provides a benchmark dataset and experimental framework that can support future PTO optimization. Future sea trials will complement these findings and provide a more complete power matrix under real ocean conditions.

## Off-grid Households in Queensland: Technologies, Intentions and Policy Implications

Dr Peyman Akhgar<sup>1,2</sup>, Dr Sylvie Chell<sup>1,2</sup>, Dr Heather Shearer<sup>1,2</sup>, Mrs Anna Petrova<sup>1,2</sup>, Dr Mohammad J. Sanjari<sup>1,2</sup>, Dr Ruby N. Michael<sup>1,2</sup>

<sup>1</sup>School of Engineering and Built Environment, Griffith University Griffith University, Brisbane and Gold Coast, Australia, <sup>2</sup>Green Infrastructure Research Labs (GIRLS), Griffith Institute for Human and Environmental Resilience, Griffith University, Brisbane and Gold Coast, Australia

### **Biography:**

*Dr Peyman Akhgar is a Lecturer in Architecture and Design in the School of Engineering and Built Environment at Griffith University. Peyman's research interest lies in the critical role of architecture as an 'agent of change' to create meaningful and sustainable places in the Global South and Australia.*

As small-scale renewable technologies become more accessible, popular, and affordable, the government and utility providers are concerned that more households may choose to disconnect from the centralised grid. In Australian states, Queensland has the highest number of PV systems — around 1.2 million — and an engaged community of off-grid residents. Despite this, there is no official data on how many households are living off-grid, nor is there centralised information on the technologies employed or reasons for opting out. This paper examines the motivations and decision-making processes of off-grid households in Queensland, highlighting the impact of these data on policy processes and decision-making. It also extends earlier research conducted in Tasmania by Heather Lovell and Phillipa Watson (2019).

This mixed-method approach uses a Qualtrics survey to gather data on off-grid households in Queensland. Participants were recruited through off-grid interest groups online and at off-grid events. All participants were provided with an information sheet and gave their informed consent to participate in the research in accordance with ethics clearance (Ref No: 2025/357).

Survey participants (n=38) represented a range of age groups and contexts. Households included couples, multi-generational, singles and most respondents did not have children. Common housing types were a classic house, followed by a tiny house on wheels. The year of disconnection ranged from ~40 years ago up until 2025. The highest proportion of disconnections has occurred since 2020 compared with prior to 2020. Thematic analysis of reasons for living off-grid were predominantly financial (47%) and environmental (32%) with other reasons including: necessity due to no option to connect (26%), independence (21%), and biophilia (16%). Drawbacks of living off-grid included the reliability of supply and weather dependence (45%) > technical challenges (25%) > repairs (20%) > setup cost (15%). A fair proportion (20%) of respondents reported that they did not experience any drawbacks.

This research is the largest of its kind in mainland Australia to explore the motivations, small-scale renewable technologies, and policy implications associated with people living off the grid. It emphasises that as the number of off-grid residents grows, more data is essential for developing inclusive energy policy frameworks.

## Opportunities and Challenges in Decarbonising the Critical Mineral Industry: A Case Study in Indonesia

Mr Muhammad Saladin Islami<sup>1</sup>, Mrs Tania Urmee<sup>1</sup>, Mr Christopher Lund<sup>1</sup>, Mrs Parissa Bahri, Mr Md Anissuzaman<sup>2</sup>

<sup>1</sup>Murdoch University, Perth, Australia, <sup>2</sup>UNESCAP, Bangkok, Thailand

### **Biography:**

*Currently, Saladin is a PhD student at the School of Engineering and Energy, Murdoch University. Saladin holds a master's in Renewable and Sustainable Energy from Murdoch University, Australia. He has been working in the energy industry for more than 10 years, from the oil and gas industry to renewable advocacy.*

The opening of new mining and processing facilities to meet the growing demand of critical minerals for achieving net-zero can add pressure on the environment, particularly in developing countries like Indonesia. Unfortunately, the current literature on the decarbonisation strategies in these critical mineral industries, such as nickel, tends to be isolated and does not incorporate various stakeholders' perspectives.

This study aims to identify the potentials, constraints and enabling mechanisms to decarbonise the critical mineral industry through different lenses of stakeholders' viewpoints. This study will solve the pressing need for in-depth evaluations to inform decision-makers and stakeholders, offering insights that effectively mitigate emissions in the industry.

This study started with the identification of drivers, barriers, and enablers from the literature and company reports. A Likert-scale survey questionnaire was distributed to the key stakeholders in the industry, comprising government officials, academia and researchers, as well as professionals representing mining companies and their users in the supply chain, and followed up with interviews. The data from the survey and interview were analysed using a Likert-scale visualisation and coded.

The results show that researchers and governments representative identifies that the existing climate commitments in Indonesia, such as the Nationally Determined Contributions, are the key drivers. However, the company representatives identify that the pressure from shareholders and financial institutions is the main driver for the mining and mineral processing companies to decarbonise the industry.

Despite the variation in key drivers, most stakeholders agree that renewable integration is the main enabler for emissions reduction in this critical mineral industry. Most stakeholders also agree that academia and research institutions have a significant interest in decarbonising this industry, although their influence is not as strong as the government. Unfortunately, the influence and interest of the local community, workers, and suppliers on emissions reductions is low. Therefore, awareness raising is critical to help increase the interest of these groups.

In conclusion, the lack of consensus between stakeholders in decarbonising the industry happens due to the differences in their mental models. This study closes the gaps by highlighting these differences and providing an alternative mental model for these stakeholders.

## Optimal Energy Management of a Stand-Alone Utility-Scale Hybrid Power Plant

Mr Muhammad Zeeshan Tariq<sup>1</sup>

<sup>1</sup>Edith Cowan University Joondalup, Perth, Joondalup, Australia

### **Biography:**

*I am Muhammad Zeeshan Tariq, currently pursuing a PhD in Electrical Power Engineering at Edith Cowan University, Perth Australia. My research focuses on optimal energy management and control of hybrid power plants, emphasizing advanced optimization-based techniques. I authored and co-authored several conference papers in renewable energy and power system optimization.*

### 1- Introduction

Hybrid advanced renewable resourced power system have light up as effective environmentally friendly trending solution to support standalone photovoltaic PV and wind power resources and exclusively withstand the unpredictable variations and uncertainties arises in nature parameters change. Proposed technique based on hybrid PV-battery-wind configured and integrated advanced management with dual-optimized technology ensured stable continuous operation regulating balanced bus output voltage despite variable demand load, uncertainties in environmental changing parameters. Main concern focused on to develop reliable, effective, high performance, by integration and deployment of advanced modern global search capabilities of Particle Swarm Optimization (PSO) with the rapid fine-tuning advantages of Improved Human Evolutionary Optimization (IHEO).

### 2. Methodology

This study proposed utility scale hybrid power plant which consists on 600-KW photovoltaic, 600-KW wind renewable turbine, 400 KWh energy storage battery units inter-linked to developed common sustainable robust continuous power source. MATLAB-Simulink based model developed with deploying efficient algorithm to simulate system dynamics under variable loads, wind speeds, and irradiance. The Dual IHEO-PSO ensured the optimal reference values for PV, wind, and battery power flows to reduce the error between load demand and available power. The optimization cost function takes into consideration power mismatch, DC-bus voltage stability, and battery state-of-charge (SOC) constraints. The simulation results are contrasted with classical control approaches.

### 3. Results and Discussion

Simulation based response illustrates that the Dual-IHEO-PSO approach effectively enhances hybrid power system performance with advanced technique. The DC-bus voltage is kept close to 800 V with little variations, and power mismatch is reduced even during unexpected environmental changes by deploying effective optimized algorithm. Compared to conventional controller approach, energy losses are reduced significantly, and battery cycle stress is greatly reduced. The dual loop cascade controller drive by reference current generation of coupled advanced-dual-IHEO-PSO algorithm delivers faster dynamic behavior and more consistent global optimization.

### 4. Conclusion

Research found that integrating PV, wind, and battery systems in advance manner with dual advanced IHEO-PSO optimization control topology improves efficiency, reliability, and lowers energy prices, effectiveness, tolerable to environmental change. Future research may involve real-time hardware testing, forecasting-based control, and larger-scale grid-connected deployments.

## Optimal Energy Management of hybrid renewable energy systems for brewery thermal processes

Mr Joseph Eminsang Conduah<sup>1</sup>, Professor Kanzumba Kusakana<sup>1</sup>, Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>

<sup>1</sup>Central University Of Technology, Free State, South Africa, Bloemfontein, South Africa

### **Biography:**

*Joseph Eminsang Conduah is a lecturer and doctoral student in Electrical, Electronic and Computer Engineering at the Central University of Technology, Free State, South Africa. Kanzumba Kusakana is a professor and head of the same department, while Olumuyiwa Yinus Odufuwa is a senior lecturer in Mechanical and Mechatronic Engineering.*

Brewing operations are highly energy-intensive, with thermal processes such as heating and cooling accounting for nearly 80% of total energy demand. Effective energy management is therefore crucial for reducing costs and improving sustainability. Rising electricity tariffs and stricter environmental regulations in South Africa further increase operational pressures on small and medium breweries. This study presents an optimal energy management strategy for a microbrewery using a hybrid renewable energy system that integrates solar thermal collectors, a heat pump, and thermal energy storage (TES). A mixed-integer nonlinear programming (MINLP) model, implemented in MATLAB with the SCIP solver, schedules energy flows under Time-of-Use (TOU) tariffs, reducing grid dependence while maximizing renewable energy use. Simulation results demonstrate significant improvements: energy costs are reduced by 72.78% in summer and 75.21% in winter, with an average annual saving of 73.53%, alongside substantial reductions in carbon emissions. Economically, the system achieves a payback period of 1.25 years and projected lifetime savings of ZAR 65.75 million (USD 3.65 million) over 20 years, representing a 74.31% reduction in lifecycle costs compared with conventional heating systems. These findings confirm the feasibility, economic viability, and environmental benefits of hybrid renewable energy integration, providing a novel approach to enhance efficiency, reduce costs, and support sustainable operations in brewery and other energy-intensive industrial sectors.

## Optimal Sizing of Hybrid PV–Battery–Electrolyser–Fuel Cell Systems for Cost-Effective Hydrogen in Remote Microgrids

Mrs Rokhana Yasmin<sup>1</sup>, Dr Md Nurun Nabi<sup>1</sup>, Dr Kalam Azad<sup>1</sup>, Dr Md Alamgir Hossain<sup>2</sup>

<sup>1</sup>Central Queensland University, Melbourne, Australia, <sup>2</sup>University of Southern Queensland, Toowoomba, Australia

### **Biography:**

*Rokhana Yasmin is a PhD candidate at Central Queensland University, Australia, researching sustainable hydrogen production in DC microgrids. She holds degrees from Federation University and DUET, with awards including a Gold Medal and Dean's Award. With 13 years' industry experience, her interests span hydrogen, microgrid, energy storage, and demand-side management.*

Decarbonising regional microgrids is an emerging challenge as communities transition toward renewable energy and hydrogen-based solutions. The intermittent nature of solar energy, combined with the cost and reliability of storage technologies, makes system design and sizing a critical problem. Determining the optimal configuration of photovoltaic (PV) generation, battery storage, electrolyser, and fuel cell (FC) systems is a key issue. Oversizing any component often results in low utilisation, increased costs, and wasted generation, while under sizing leads to reliability shortfalls and insufficient hydrogen production. Therefore, practical methods are required to balance reliability, affordability, and efficiency in renewable-integrated microgrids.

This study proposes a techno-economic optimisation framework to address this challenge. Using HOMER Pro, hourly solar and load data for a representative Queensland remote community were analysed. The scenarios considered different PV sizes, battery durations (0, 4, and 8 hours at peak load), and electrolyser/FC capacities under two dispatch strategies (excess generation-only and daytime-only operations). System performance is assessed using multiple indicators including levelised cost of energy (LCOE), levelised cost of hydrogen (LCOH), net present cost (NPC), electrolyser and FC capacity factors, and hydrogen shortfall percentages.

Simulation results indicate that a carefully matched PV–battery–electrolyser–FC combination improves electrolyser utilisation and reduces unmet hydrogen demand compared to poorly configured setups. Moderate battery integration played a crucial role in smoothing PV variability, thereby enhancing the electrolyser CF and improving system stability. In contrast, simply increasing PV capacity beyond the base case led to significant excess electricity generation, while only marginally increasing hydrogen output. For example, a 25% PV oversizing slightly reduced (–3.5%) annual hydrogen yield, increased battery throughput by ≈5.1%, and raised system costs with wasted generation. These findings highlight, overinvestment in PV capacity is not an effective strategy for reducing LCOH at the studied site.

In conclusion, this research provides evidence that optimal system sizing is a practical pathway to achieving affordable hydrogen production and reliable energy supply in remote microgrids. Future work will focus on incorporating dynamic models of electrolyser and FC behaviour, degradation impacts, and integration within DC microgrid energy management systems to further improve the accuracy and applicability of the optimisation framework.

# Optimising Tailrace Hydrokinetic Integration for Enhanced Hydropower Performance

Prof Kanzumba Kusakana<sup>1</sup>

<sup>1</sup>Central University Of Technology, Free State, Bloemfontein, South Africa

## **Biography:**

*Prof. K. Kusakana is a leading researcher in electrical engineering, specialising in renewable energy systems, hydropower, hydrokinetic integration, and smart grids. With advanced degrees in engineering and business, he has authored numerous high-impact publications, supervised postgraduate research, and contributed significantly to sustainable energy development in Africa and beyond.*

## **Introduction:**

The growing demand for renewable energy necessitates innovative approaches to maximise generation from existing infrastructure. Hydropower plants with tailraces provide an untapped opportunity to harness residual kinetic energy through hydrokinetic turbines. This study addresses the challenge of optimally integrating hydrokinetic energy recovery into conventional hydropower operations, aiming to enhance total energy output, reduce operational costs, and improve overall system efficiency under real-world hydrological and market conditions.

## **Methodology:**

A hybrid system model was developed combining a reservoir-based hydropower plant with downstream hydrokinetic turbines. The framework incorporates a site-specific nonlinear function linking hydropower discharge to hydrokinetic inflow velocity, calibrated using data from a tailrace in southern Poland. Three dispatch strategies, open-loop control, closed-loop control, and Model Predictive Control (MPC) were formulated to coordinate hydropower and hydrokinetic generation with grid interaction. The model integrates exogenous hydrological factors such as evaporation and precipitation to capture reservoir dynamics and applies a nonlinear optimisation routine to minimise total electricity procurement costs while meeting demand.

## **Results and Discussion:**

Simulation results indicate that under MPC, the hybrid system achieved a hydrokinetic capacity factor of 27.7%, leading to annual energy cost savings of 3.42% and an energy consumption reduction of 4.26% relative to the baseline hydropower-only operation. The optimisation effectively shifted hydropower dispatch toward high-price periods while utilising hydrokinetic generation to capture otherwise wasted kinetic energy during lower-demand intervals. Comparative analysis revealed that MPC consistently outperformed open-loop and closed-loop strategies in both cost and energy savings.

## **Conclusion:**

This work demonstrates that integrating hydrokinetic turbines into hydropower tailraces can yield measurable energy and economic gains without significant environmental disruption. By combining detailed hydrodynamic modelling with advanced optimisation strategies, the study provides a decision-support framework for enhancing the productivity of existing hydropower assets. The findings support targeted deployment in regulated, high-velocity tailraces with existing grid infrastructure, while emphasising the need for site-specific feasibility assessments. Future work should address long-term operational data collection, explore hybridisation with other renewables, and evaluate regulatory mechanisms to support commercial adoption.

## Optimization Method of Jacket Foundations for Offshore Wind Turbines Considering Wind, Wave and Current Loads

Dr Sharath Srinivasamurthy<sup>1</sup>, Mr Takahiro Nagatsu<sup>2</sup>, Mr Kaung Khant Soe<sup>1</sup>, Dr Mostafa Rushdi<sup>1</sup>, Dr Shigeo Yoshida<sup>1,3</sup>

<sup>1</sup>Institute Of Ocean Energy, Saga University, Saga city, Japan, <sup>2</sup>ENEOS Renewable Energy, Minato, Japan, <sup>3</sup>Research Institute of Applied Mechanics, Kyushu University, Kasuga, Japan

### **Biography:**

*Assistant Professor at the Institute of Ocean Energy, Saga University, Japan.*

Offshore wind energy is increasingly recognized as one of the vital contributors to global renewable energy development. Jacket-type foundations have become a preferred option of sub-structure in deeper waters since they offer superior stiffness and provides greater stability during energy production. However, the growing scale of offshore wind turbines introduces new challenges in designing and optimizing jacket configurations to withstand different environmental conditions. Therefore, the objective of this research is to develop an optimization program for the jacket foundation to reduce the overall mass while still maintaining sufficient structural integrity. The research methodology employed a computational approach to optimize the jacket foundation for a 15MW wind turbine under wind, wave and current loads. A jacket foundation typically consists of a main structure and braces connecting the main structure. In this study, the diameter and thickness of the main structure and braces along with the leg width were considered as the design variables. The range for each design variable is predefined and an optimization program was developed in MATLAB in conjunction with Frame3DD, an open-source frame analysis software. The structural modelling was carried out in Frame3DD to evaluate stiffness and stress distribution under various loading conditions. The objective function of the optimization is minimum structural mass that also satisfies the structural strength criteria. The structural strength criteria are evaluated by defining effort which is the ratio of the compressive stress and buckling stress of each member to their allowable values. Round-robin optimization method is employed and the optimal jacket foundation which satisfies the structural criteria and minimum structural mass is obtained. Further, to validate the optimization program, a Genetic Algorithm (GA) based optimization method was employed for the analysis and optimized jacket foundation is obtained. It was confirmed from the comparisons that the results obtained from the round-robin optimization method matches well with the GA based optimization method. It is found from the optimization results that the minimum structural mass required to host a 15 MW wind turbine is 1033 ton. It is also found that GA based optimization saves computation costs than round-robin optimization method.

## Optimizing Artificial Lighting in Waterfront Pathways for Enhanced Safety Perception and Energy Efficiency

Miss Jingyi Liu<sup>1</sup>, Prof Jianfei Chen<sup>1</sup>

<sup>1</sup>Harbin Institute Of Technology, Harbin, China

### **Biography:**

*Liu Jingyi is a Ph.D. candidate in the School of Architecture and Design at Harbin Institute of Technology.*

*Chen Jianfei is a Professor and Doctoral Supervisor in the School of Architecture and Design at Harbin Institute of Technology.*

High-quality lighting in urban public spaces is crucial for enhancing pedestrian safety, promoting nighttime vitality, and advancing urban sustainability. As a key component of the built environment, waterfront pathways often suffer from inadequate lighting, leading to poor visibility, increased fear of crime, and reduced nighttime utilization. This study investigates the impact of optimized artificial lighting on pedestrians' safety perception and evaluates its energy-saving potential, using Harbin's Majiagou River waterfront pathway as a case study. A mixed-methods approach was adopted, integrating survey data from 106 pedestrians, field lighting measurements, and simulations using DIALux software. Key lighting parameters such as illuminance, Unified Glare Rating, and uniformity were systematically evaluated across six lighting scenarios and compared with the existing conditions. The results indicate that a strategic combination of high-pole and embedded edge lighting significantly improves visual comfort and perceived safety. Crucially, the study demonstrates that, while meeting equivalent safety requirements, optimized photometric design can reduce lighting energy consumption to below  $3.2 \text{ W/m}^2$ , representing an approximately 15% reduction compared to conventional design schemes. This research provides empirical evidence and an actionable technical pathway for achieving safe, comfortable, and energy-efficient public space lighting within the framework of sustainable cities and smart energy management.

## Performance Analysis of the 180-kW Pilot Solar Farm in Rubesa, Bhutan

Mrs Karma Yangden<sup>1</sup>, Dr Elaine Walker<sup>1</sup>, Professor Tania Urmee<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Dr Walker has a long interest in energy efficiency and renewable energy, especially solar photovoltaics. She has been involved with the Energy Studies degrees at Murdoch University since she completed her PhD on solar cell material properties.*

Bhutan's electricity sources have been dominated by hydropower, which is threatened by climate change and already requires the purchase of electricity from neighbouring countries in the winter. To reduce this dependence, other clean electricity sources such as photovoltaics are being prioritised. This study aimed to comprehensively evaluate the performance of the 180 kW grid-connected solar photovoltaic (PV) system installed in Rubesa, Wangdue Phodrang, Bhutan. As the country's first utility-scale PV plant, the project represents a significant milestone in diversifying Bhutan's renewable energy portfolio beyond hydropower. Using real-time operational data from 2022 and appropriate climate data from NASA for that year, the technical performance of the system was assessed through key performance indicators (KPIs) such as Final Yield, Array Yield, Reference Yield, Performance Ratio (PR), and Capacity Factor (CF), as per IEC 61724-1 guidelines. The results indicated an annual average PR of 86.3% and CF of 18.2%, highlighting efficient system operation across diverse seasonal conditions.

To determine the validity of models based on the photovoltaic system, the RETScreen Expert Software was employed to simulate expected energy outputs based on environmental parameters and compare it to the observed performance, with statistical tools such as MAPE (4.14%, indicating mean absolute percentage error), RMSE (1232.54kWh, representing the root mean square error between the actual and predicted outputs),  $R^2$  (0.6954, indicating model fit) used to quantify predictive accuracy. A Cumulative Sum (CUSUM) analysis further revealed periods of minor underperformance and recovery, demonstrating the model's effectiveness in capturing long terms trends.

Comparative analysis with similar grid-connected PV systems worldwide confirmed the Rubesa plant's competitive efficiency, particularly in high-altitude climates. The findings underscore the viability of solar PV systems in Bhutan's mountainous regions and offer valuable insights for scaling future solar projects. Ultimately, this study contributes to Bhutan's long term energy security and supports its transition to a diversified and resilient renewable energy system.

## Performance Evaluation of a PCM Thermal Battery Integrated with a Heat Pump System

Mr SEUNG HO LEE<sup>1</sup>, Mr. YUXIANG SHAO<sup>2</sup>, Mr. Michel Bostrom<sup>2</sup>, Mr. XIAO SU<sup>1</sup>, Miss TONGYAN CUI<sup>1</sup>, Professor Jun Ma<sup>1</sup>, Professor Wasim Saman<sup>1</sup>

<sup>1</sup>University Of South Australia, Mawson Lakes, Australia, <sup>2</sup>Isothermix, Salisbury North, Australia

### **Biography:**

*Dr. Seung Ho Lee, PhD in Mechanical Engineering (University of South Australia, 2020), is Chief Scientific Officer at Isothermix and a researcher at UniSA. He specializes in developing cost-effective, environmentally friendly phase change materials and designing PCM thermal batteries to enhance building energy efficiency and thermal storage performance.*

The increasing demand for heating, coupled with fluctuating energy costs and the expansion of variable renewable energy sources, presents new challenges and opportunities for building heating system efficiency. This study investigates the application of a salt-hydrate phase change material (PCM) thermal battery to enhance water heating systems by recovering wasted heat. A modular 1.3 m<sup>3</sup> PCM thermal battery, employing a PCM with a melting point of 25°C, was designed and manufactured to store low-grade heat and supply warm water at approximately 22°C. The heating performance of the thermal battery was evaluated experimentally, simulating integration into a commercial water heating system. The feasibility of retrofitting this PCM thermal battery into boiler systems was also explored. An optimized heat exchanger design, developed through mathematical simulations and extensive testing, enabled effective operation under diverse scenarios, providing peak load-shifting capabilities and improved economic efficiency. A practical demonstration replacing a conventional gas boiler with a combination of HVAC and PCM thermal battery highlighted measurable improvements in thermal efficiency and responsiveness to peak heating demands. The results underscore the PCM thermal battery's potential as an autonomous component in building heating systems, delivering both environmental and economic benefits by efficiently capturing and utilizing otherwise wasted heat.

## Performance of Fly Ash-Based Geopolymer Self-Healing Repair Mortar

Dr Puput Risdanareni<sup>1</sup>, Dr.Eng Januarti Jaya Ekaputri<sup>2</sup>, Prof. Dr. Stefanus Adi Kristiawan<sup>3</sup>, Dr Rahmi Karolina<sup>4</sup>, Dr Martin Anda<sup>5</sup>

<sup>1</sup>Universitas Negeri Malang, Malang, Indonesia, <sup>2</sup>Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia, <sup>3</sup>Universitas Sebelas Maret, Surakarta, Indonesia, <sup>4</sup>Universitas Sumatera Utara, Medan, Indonesia, <sup>5</sup>Murdoch University, Perth, Australia

### **Biography:**

*Puput Risdanareni is a lecturer at Universitas Negeri Malang (UM). She earned her doctoral degree in civil engineering at Ghent University Belgium in 2021. Her research were published and presented at various international forums, such as RILEM annual week 2021 and 2022, Construction and Building Materials Journal, and many more.*

Hydrogel-based self-healing mortars often suffer from reduced mechanical strength due to the presence of hydrogels. Although previous studies have explored low-swelling hydrogels and crystalline admixtures to address this issue, the need for repair mortars that are both strong and fast-setting remains unresolved. This study investigates the use of a fly-ash-based geopolymer binding system to overcome these limitations in self-healing repair mortar. Geopolymer mortar were prepared using sodium hydroxide concentrations of 8 M and 10 M, an alkaline activator ratio of 1.5, a hydrogel dosage of 0.24%, and a liquid-to-solid ratio of 0.5. Setting time, compressive strength, healing capacity, and bond strength were evaluated. The results indicate that the geopolymer binder effectively mitigates the strength reduction typically associated with hydrogels. Moreover, geopolymer mortar incorporating hydrogel demonstrated higher healing capacity and bond strength compared to mortar with an ordinary Portland cement (OPC) binding system. Overall, the findings suggest that fly-ash-based geopolymer systems provide a greener alternative for self-healing repair mortars with adequate mechanical performance and enhanced healing capability, offering promising pathways for future mix optimization.

# Physics-Regularized Neural Surrogates for Solar-Powered Organic Rankine Cogeneration: Real-Weather Forcing with Exergy-Aware

Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>, Mr Tolulope Ekunseitan<sup>1</sup>

<sup>1</sup>Central University Of Technology, Bloemfontein , South Africa

## **Biography:**

*Olumuyiwa Yinus Odufuwa (Senior Lecturer) and Tolulope Ekunseitan (postgraduate), Dept. of Mechanical & Mechatronic Engineering, Central University of Technology, Free State, South Africa. Doctor of Engineering in Mechanical Engineering. Research interests include energy management, ice thermal energy storage, solar-HVAC systems, renewable energy technologies, and applied artificial intelligence.*

## Introduction

Solar-thermal driven Organic Rankine Cycle (ORC) cogeneration is a renewable heat and power generation but strongly influenced by solar variability, working fluid properties, and operation conditions. Although thermodynamic models are accurate, they are computationally intensive, and data-driven approaches like Artificial Neural Networks (ANNs) are usually not physics-conformant. In this paper, a physics-regularized neural surrogate is suggested for improving prediction and optimization of solar-ORC cogeneration with exergy constraints and real-weather forcing.

## Methodology

Grey-box network was developed by integrating a digital twin of parabolic-trough collector and ORC system with a physics-regularized ANN. Open-source meteorological datasets (irradiance, temperature, wind, humidity) were employed as inputs and net power, thermal output, exergy efficiency as outputs. Penalty terms to enforce energy balance and exergy constraints were applied for training the ANN. Cross-validation, Monte Carlo dropout to derive uncertainty, and SHAP analysis for explainability were employed. Benchmarking was against a black-box ANN and a first-principles model, which tested accuracy and robustness.

The surrogate was able to produce mean absolute errors of less than 4% for power and 6% for heat, 35% more accuracy than unconstrained ANNs. Cross-climate validation tests generalized better in unseen areas. SHAP revealed irradiance and expander inlet pressure were important variables, with ambient temperature and wind having an impact on condenser dynamics. Computation was as fast as 30 times that of first-principles simulations, opening up applications in real-time.

## Conclusion

The physics-regularized ANN efficiently alleviates physical rigor and predictive performance for solar-ORC cogeneration. It offers a window for real-time monitoring and optimization, though field-scale system validation and integration into thermal storage are areas of future work.

# Physics-Regularized Neural Surrogates for Solar-Powered Organic Rankine Cogeneration: Real-Weather Forcing with Exergy-Aware Learning

Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>, Mr Tolulope Ekunseitan<sup>1</sup>

<sup>1</sup>Central University Of Technology Free State, Bloemfontein, South Africa

## **Biography:**

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## Positive Media Coverage and ESG Performance: Symbolic Legitimacy or Substantive Improvement

Miss Yujie Zhu<sup>1</sup>, Dr. Rabindra Nepal<sup>1</sup>, Dr. Xuefeng Shao<sup>1</sup>

<sup>1</sup>University of Newcastle, Newcastle, Australia, <sup>2</sup>The University of Wollongong, Wollongong, Australia

### *Biography:*

*I am Yujie Zhu, a Ph.D. candidate at the University of Newcastle. My research focuses on ESG, digital transformation, and green innovation. I have published in Technological Forecasting & Social Change on 'The Impact of Climate Risk on Technological Progress under the Fourth Industrial Era.*

Media coverage is a primary channel through which stakeholders evaluate firms' environmental, social, and governance (ESG) performance. While negative coverage often disciplines organizations by exposing failures, positive coverage is frequently accepted without scrutiny, raising the risk that it may encourage symbolic legitimacy rather than substantive ESG improvements. This study examines whether positive media coverage enhances or undermines ESG performance and under what conditions it shapes organizational outcomes.

We draw on agenda-setting theory and the contingency perspective to examine whether positive media coverage incentivizes symbolic ESG behavior. Using 2,401 firm-year observations of US S&P 500 firms from 2004–2023, we measure media coverage through text analysis of Factiva news articles with LIWC and assess ESG performance using MSCI KLD ratings. Moderating factors include political leaning (based on state-level election results), CEO compensation (ExecuComp), and carbon emission management (MSCI). Firm financials are obtained from Compustat. We estimate regression models with firm and year fixed effects and address endogeneity concerns through instrumental variable two-stage least squares (2SLS).

The findings indicate that positive media coverage is negatively associated with ESG performance, supporting the argument that positive media coverage often reflects symbolic legitimacy rather than substantive improvements. The effect is stronger in Republican-leaning states, where institutional ESG pressures are weaker, while higher carbon emission management scores reduce the negative impact by constraining symbolic behavior. CEO compensation further weakens the relationship, suggesting that misaligned incentives diminish responsiveness to media signals. These results highlight that the influence of media on ESG outcomes is contingent on political, governance, and environmental contexts.

This study challenges the previous assumption that positive media coverage improves ESG performance, extends agenda-setting theory and the contingency perspective into the ESG literature, and bridges the two by clarifying boundary conditions under which media coverage promotes symbolic versus substantive ESG actions. The findings suggest that managers should ensure media narratives reflect substantive ESG practices, investors should look beyond media signals to identify greenwashing, and policymakers should strengthen ESG verification and disclosure. The study's U.S. focus and reliance on secondary ratings limit generalizability, and future research could extend to cross-country settings and explore managerial responses through qualitative methods.

## Power Prediction and Fault Detection Simulation Study for a Photovoltaic Digital Twin Application

Mr Ammar Elnosh<sup>1</sup>, Dr Martina Calais<sup>1</sup>, Assoc Prof David Parlevliet<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Ammar Elnosh is a PhD candidate at Murdoch University under the School of Engineering and Energy. His research background covers photovoltaic (PV) module and system performance and reliability, with a special interest in Digital Twin applications for PV power prediction and diagnostics.*

### Introduction

Standalone photovoltaic (PV) power systems play a major role in the electrification of remote and off-grid areas, however, their performance is heavily impacted by variabilities in environmental conditions in addition to various faults and degradation mechanisms. Digital Twin technology is an emerging innovation with significant potential to address such challenges, by serving a wide range of applications such as adaptive power prediction and the detection, classification, and prediction of faults. This simulation study aims to provide a proof-of-concept for the efficacy of data-driven PV digital twins (PVDTs) for simultaneous reliable power prediction and fault detection and classification.

### Methodology

The study is conducted using MATLAB/Simulink, where a standalone PV system is modelled including a 3 kW PV array, a 48V battery pack, MPPT charge controller and inverter. The system is simulated using plane-of-array irradiance and module temperature data collected in the period 2011-2012 at Murdoch University's Perth campus. Using the weather data and simulated PV power, three machine learning (ML) algorithms are trained on 2011 data, namely: linear regression, random forest, and feed-forward artificial neural network (ANN). Various fault conditions are then introduced to the simulated 2012 PV data, including open-circuit faults, shading, and irradiance sensor faults. The ML algorithms are then validated on the 2012 data (including faults). The ANN algorithm is further adapted using a residual-based exponentially weighted moving average (EWMA) corrector that enables it to learn from PV system drifts and accordingly adapt the model output. For the final paper submission, fault detection and classification methods will be integrated and validated to showcase capabilities for simultaneous prediction and diagnostics within a data-driven PVDT framework.

### Preliminary Results

Preliminary simulation results show that ANN has the best performance among the basic algorithms tested on 2012 data, and that the ANN adaptation improves the prediction under the presence of fault conditions.

### Conclusion

The study emphasizes the PVDT potential for adaptive prediction with diagnostic capabilities. In the final paper, the data-driven models' performance under specific fault conditions will be presented in addition to results for fault detection and classification.

## Predicting biomass hydrothermal liquefaction with physics informed machine learning approach

Mr Tossapon Katongtung<sup>1</sup>, Dr Thossaporn Onsree<sup>1</sup>, Prof Nakorn Tippayawong<sup>1</sup>

<sup>1</sup>Chiang Mai University, Chiang Mai, Thailand

### **Biography:**

*Mr Tossapon Katongtung is currently a research student in a graduate PhD program in Energy Engineering, Faculty of Engineering, Chiang Mai University, Thailand. His research focuses on hydrothermal processing of biomass and wastes, deploying experimentation, process simulation and machine learning techniques.*

The growing demand for renewable energy has highlighted hydrothermal liquefaction (HTL) as a promising pathway for converting high moisture and wet biomass into energy-dense bio-oil, contributing to the global transition toward net zero emissions. However, the nonlinear and complex interactions of HTL process variables make accurate prediction and optimization of product yields highly challenging. The objective of this study is to develop a machine learning (ML) model that explicitly integrates simulation data grounded in physical principles with experimental datasets, thereby establishing a physics-informed ML framework tailored for HTL.

The methodology involves multiple input features (from experimental conditions and raw biomass properties) and one target output (bio-oil yield), representing critical HTL parameters. Two modeling strategies were compared: (i) a baseline ML model trained solely on experimental data, and (ii) a hybrid physics-informed ML model that integrates experimental and simulation data to embed physics-based knowledge. It was found that the baseline model achieved a coefficient of determination ( $R^2$ ) of 0.74, while the hybrid model delivered superior predictive accuracy with  $R^2$  of more than 0.80. These findings confirm that incorporating simulation data rooted in physical laws not only mitigates the limitations of sparse and uncertain experimental data but also improves generalization and reliability of the predictive model. Highly influential features on predictions of the hybrid model were also investigated.

In the broader context of renewable energy and decarbonization, this study demonstrates how physics-informed ML approaches can accelerate the optimization of HTL processes, enabling more efficient bio-oil production. By improving process predictability, hybrid models contribute to advancing biomass utilization as a part of the pathway to net zero emissions. While also underscoring the need for future studies to expand datasets, the research highlights a methodological advancement with implications for sustainable fuel development, integrates more comprehensive physics-based constraints, and extends applications across diverse biomass feedstocks and operating conditions.

## Prospects for Net-Zero Urban Regeneration: a policy review for Australian cities.

Jillian Bardos<sup>2</sup>, Mr Patrick Bendall<sup>1</sup>, Dr Giles Thomson<sup>1</sup>

<sup>1</sup>Curtin University Sustainability Policy Institute, School of Design and Built Environment, Perth, Australia, <sup>2</sup>City of Bayswater, Perth, Australia

### **Biography:**

*Dr Giles Thomson is an urbanist and senior lecturer with experience across academia, industry, and government. He researches and teaches about regenerative urbanism in Australia and internationally.*

*Patrick Bendall is a registered architect and lecturer who researches and teaches about architecture and computation, with industry experience in design and delivery.*

Australian cities face the dual challenge of accommodating a rapidly growing population while transitioning to net-zero emissions (CO<sub>2</sub>-e) within a changing climate. Innovative models of net-zero urban regeneration present an opportunity to meet Australia's commitments to decarbonise the economy while addressing the urgent need for new, well-located homes.

To address Australia's housing crisis, the National Housing Accord calls for 1.2 million new well-located homes to be built over 5 years from mid-2024. Concurrently, the Australian economy has ten years to effectively halve its emissions to meet its target for 62-70% emission reduction below 2005 levels by 2035. Success will require deep decarbonisation in our cities, to tackle both operational and embodied emissions. Environmental regulation is often described as 'green tape' slowing housing supply, but what if housing supply was viewed as a catalyst for meeting Australia's emissions targets?

Australian planning policy is an often-overlooked vehicle for driving systemic environmental change. In contrast to inefficient, emission-intensive, low-density greenfield expansion on the fringes of many Australian cities, urban regeneration (i.e. development within existing urban areas) has great potential to decarbonise cities and provide well-located housing. This paper will present the findings of a literature review into strategic urban policy measures across Australia to answer the question: What are the opportunities and barriers within the Australian planning system for delivering net-zero (CO<sub>2</sub>-e) and sustainable urban regeneration? It draws upon both academic and grey literature, to examine existing opportunities and barriers for urban regeneration including an examination of contemporary low carbon technologies and innovations in the built environment sector (including urban form, transport, buildings, and construction materials).

The review identifies actionable policy pathways to better integrate net zero urban regeneration strategies into national housing and net-zero frameworks. It argues for governance reform and coordination between different levels of government to deliver compact, energy-efficient, and transit-oriented urban environments.

## Pyrolysis of torrefied palm kernel shells in a high throughput ablative reactor and its economics

Dr Nattawut Khuenkaeo<sup>1</sup>, Mr Watcharapol Insom<sup>2</sup>, Mr Tossapon Katongtung<sup>2</sup>, Dr Thossaporn Onsree<sup>2</sup>, Dr Chawannat Jaroenhasemmesuk<sup>2</sup>, Prof Nakorn Tippayawong<sup>2</sup>

<sup>1</sup>Payap University, Chiang Mai, Thailand, <sup>2</sup>Chiang Mai University, Chiang Mai, Thailand

### **Biography:**

*Dr Nakorn Tippayawong is a professor at Department of Mechanical Engineering, Chiang Mai University, Thailand. He received BEng and PhD from Imperial College London, UK. His research focuses on biomass thermal conversion, energy efficiency improvement, renewable energy, decarbonization, and emission control. He has published > 250 articles, h-index = 37.*

The pyrolysis of torrefied palm kernel shells (PKS) was evaluated in a high-throughput (100-200 kg/h) ablative reactor, emphasizing material properties, product distribution, bio-oil properties, and economic feasibility. Torrefaction pretreatment significantly enhanced the physicochemical properties, resulting in improved energy density, hydrophobicity, and thermal stability. The torrefied PKS was found to have improved physicochemical properties, with a reduction in moisture from 14.05 to 11.14%, an increase in fixed carbon content from 18.47 to 26.24%, and an enhanced higher heating value (HHV) from 16.82 to 19.32 MJ/kg, compared to raw PKS. Subsequent pyrolysis of torrefied PKS produced biochar with a high carbon content of 75.68% and HHV of 28.68 MJ/kg. Analysis of product yields and distribution revealed that bio-oil was accounted for 40.5–46.5%, biochar 28–30.6%, and syngas 24.7–28.9%, respectively, depending on the torrefaction temperature, indicating that higher torrefaction degrees slightly decreased liquid bio-oil yield while increasing solid biochar. The liquid bio-oil comprised two visible fractions: organic and aqueous, whereby the organic portion was significantly increased by torrefaction and can be upgraded as a further biofuel. However, torrefaction pretreatment slightly enhanced the physicochemical properties of the organic fraction, including calorific values. The organic compounds can be significantly improved, for example, with an increase in phenolic compounds and a decrease in carboxylic acids. The findings from the economic assessment suggested favourable feasibility, with lower production costs and promising net present value under different torrefaction conditions. A simplified process flowchart could illustrate the integration of torrefaction, pyrolysis, and product separation, highlighting the potential scalability and efficiency of combining torrefaction and ablative pyrolysis for sustainable bioenergy production.

## Quantifying the economic and emissions case for renewable energy industrial precincts

Mr Max Van Someren<sup>1</sup>

<sup>1</sup>Bivios, ,

### **Biography:**

*Max is the Australian Managing Director for Bivios. He is a renewable energy techno-economics expert and engineer. His current work includes assessing the costs of green iron for The Superpower Institute, Energy Advisor for Arafura Rare Earths' Nolans Project and advising on bioenergy investments for ARIA, Bivios's parent company.*

Renewable Energy Industrial Precincts (REIPs) are concentrations of renewable energy and industrial development in specific places. They have been proposed as a key enabler for accelerating industrial decarbonisation in Australia. The potential benefits of REIPs include:

- Reduced costs of shared infrastructure (e.g. electrical transmission, road and rail connections, pipelines etc).
- Efficiency savings through increased re-use of by-products and waste-products.
- Use of renewable energy that would otherwise be curtailed.
- Enabling of collaborative industrial value chains through their co-location (e.g. hydrogen and ammonia production).
- Development of skills, knowledge and innovation potential within a cluster.

However whilst the hypothesised benefits of REIPs are explored extensively in the literature, there has been very little work to-date to quantify the economic and emissions benefits from co-location.

In this presentation, Max will describe an analysis undertaken using the Bivios energy systems model to quantify the economic and emissions benefits of industrial clustering.

To evaluate the benefits of REIPs distinct scenarios are modelled. In the first, the 'dispersed' scenario, a range of different industrial goods (e.g. steel, aluminium, ammonia, renewable fuels) are produced using renewable energy in discrete, separate facilities that do not interact with each other.

In the second, REIP, scenario, the value chains are modelled together, sharing the supply of renewable electricity as well as intermediate products such as hydrogen and water.

In both scenarios different levels of flexibility in production are explored between the different facilities, and the impact of this on the economic and emissions benefits are quantified. The impact of connection to an external electricity grid and market is also modelled.

We find that savings in renewable energy use and emissions associated with firming power are possible where REIPs contain facilities with varying levels of flexibility (e.g. an aluminium smelter that requires close to 100% up time and more flexible hydrogen electrolyzers). Initial results indicate savings of approximately 10% on the total production costs of goods within a REIP is possible using this approach.

## REAL-TIME SENSOR-DRIVEN ADAPTIVE AIR CONDITION SYSTEM FOR THE REMOTE MINING ACCOMMODATION

Mr Piumal Amarakoon<sup>1</sup>

<sup>1</sup>School of Engineering and Energy, Murdoch University, Perth, Australia

### **Biography:**

*I graduated in Mechanical Engineering from the University of Manchester in 2020 and gained five years of industry experience as a mechanical engineer in construction. In 2024, I began my Master's in Renewable and Sustainable Energy Management at Murdoch University, aiming to contribute effectively to the research stream*

Energy consumption in mining accommodations is a significant operational and environmental concern in Western Australia, where extreme seasonal temperatures challenge occupant comfort and energy efficiency. Rooms in portable mining huts often rely on manual conventional HVAC systems, leading to energy waste due to longer operation than necessary, or operation when the room is unoccupied, or inappropriate setpoints. To address these challenges, this study presents a fully deployed adaptive system that integrates environmental sensing, predictive control, and behavioural awareness to optimise indoor thermal comfort and reduce energy use.

The system incorporates temperature, humidity, and surface temperature sensors on interior and exterior walls to capture thermal gradients. A motion sensor tracks occupancy, while a BMP280 barometer near the air conditioning unit detects fan speed variations. The HVAC unit is controlled via an infrared transmitter module, enabling dynamic mode and fan speed control of the legacy AC without mechanical relays.

Data collection is performed by a third-party IoT monitoring system (ARNOWA), which records environmental parameters and HVAC operation continuously, alongside the in-built SD card in the master controller, which records all the indoor and outdoor real-time sensor readings and the decisions, target temperature and actions with the real-time stamps. The adaptive HVAC system data are compared with a "baseline room" where the AC operates 24x7 at a fixed 22°C setpoint, allowing assessment of energy savings, thermal stability, and system responsiveness. The control algorithm integrates real-time sensor inputs with short-term weather forecasts to adjust HVAC operation proactively, maintaining indoor conditions within ASHRAE 55 standards while mitigating energy wastage caused by occupant behaviour.

Data were collected over several weeks, capturing indoor temperature, humidity, surface temperatures, occupancy events, and HVAC status. System performance was evaluated relative to the baseline, focusing on energy efficiency, thermal comfort, and responsiveness to real-time environmental changes and forecasted conditions. The adaptive control system also accounts for behavioural patterns, such as leaving AC units running, by adjusting operation based on occupancy and environmental conditions.

This work comprehensively evaluates adaptive HVAC control under realistic mining accommodation conditions. The methodology demonstrates a scalable and cost-effective approach to improving energy efficiency while maintaining comfort.

## Reforming Indonesia's Renewable Investment Framework through Capacity-Based Mechanisms: Lessons from Australia's CIS

Mr Cendekia Raihan Albairuni<sup>1</sup>

<sup>1</sup>The University Of Melbourne, Parkville, Australia

### **Biography:**

*Cendekia Raihan Albairuni is a Master of Energy Systems candidate at the University of Melbourne and an LPDP awardee. With professional experience at Pertamina Patra Niaga, his research focuses on renewable investment policy, energy market design, and regional decarbonisation pathways in Southeast Asia.*

Indonesia stands at a pivotal point in its energy transition. Despite abundant solar, wind, geothermal, and biomass resources, renewables supply less than 15 per cent of national electricity generation. The existing investment framework, defined by MEMR Regulation No. 4/2020 and PLN's single-buyer procurement, relies on administratively set tariffs and long-term Power Purchase Agreements (PPAs). While this structure offers price stability, it limits competitive entry, constrains private capital mobilisation, and reduces responsiveness to declining technology costs.

Meanwhile, the Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) 2025–2034 targets 75–80 GW of new renewable capacity but simultaneously allocates over 13 GW of additional coal-fired power, reflecting ongoing policy tensions between industrial electrification and decarbonisation. Transmission bottlenecks, fiscal exposure, and the absence of capacity remuneration continue to reinforce investment risk and slow deployment.

This paper conducts a comparative legal-economic analysis of Indonesia's renewable PPA framework and Australia's Capacity Investment Scheme (CIS). Methodologically, the study employs: (1) Regulatory instrument mapping to compare tariff-setting, contract settlement structures, and risk allocation; (2) Mechanism-level evaluation of capacity auctions and revenue-underwrite designs in the CIS within the National Electricity Market (NEM); and (3) Scenario-based investment feasibility assessment to identify how analogous mechanisms could be adapted to the Indonesian market.

The analysis finds that two design features of the CIS—competitive firming-capacity auctions and dynamic revenue-band contracts (floor–ceiling settlements)—offer actionable policy translation pathways. Incorporating these mechanisms into Indonesia's forthcoming MEMR 5/2025 PPA reform would improve price discovery, enable fiscally disciplined risk-sharing, and support technology-neutral procurement. Aligning these reforms with Indonesia's downstream industrial strategy would ensure that rising industrial demand is supplied by reliable, low-carbon power.

The paper concludes that integrating capacity remuneration and revenue-band contracting within Indonesia's regulatory architecture, and coordinating these with regional interconnection under the ASEAN Power Grid, would shift Indonesia from a predominantly administratively priced system toward a transparent, capacity-enabled market. This transition would strengthen investor confidence, reduce fiscal burden, and position Indonesia as a regional leader in Southeast Asia's renewable energy expansion.

## Renewable Energy Technologies and Innovation in Bangladesh's RMG Sector

**Dr Md. Hemayet Hossain<sup>1</sup>**

<sup>1</sup>Risda-Bangladesh, Savar, Dhaka, Bangladesh, <sup>2</sup>NGO, Savar, Dhaka, Bangladesh

### **Biography:**

*Md. Hemayet Hossain, Executive Director of RISDA-Bangladesh, has 28+ years' experience in social development, gender equity, climate adaptation, and renewable energy. He leads programs in education, livelihoods, disaster preparedness, and institutional capacity building, with expertise in policy advocacy, program management, and inclusive, climate-resilient development for marginalized communities.*

## Renewable Energy Technologies and Innovation in Bangladesh's RMG Sector

### Introduction:

Bangladesh's Ready-Made Garments (RMG) sector, contributing over 84% of national exports and employing more than 4.4 million workers, is highly energy-intensive and heavily reliant on fossil fuels (BGMEA, 2023). Rising global demand for sustainable supply chains and the country's commitment to achieving net-zero emissions by 2050 necessitate the integration of renewable energy technologies. This study investigates the potential of renewable energy solutions and innovative approaches to enhance energy efficiency, reduce greenhouse gas emissions, and strengthen the competitiveness of the RMG sector.

### Methodology:

A mixed-method approach was adopted, combining literature review, case study analysis, and secondary data collection from IDCOL, BGMEA, and selected industrial zones (Gazipur, Narayanganj, Chattogram EPZ). Technical assessment of solar PV, biomass, and hybrid energy systems was performed, along with qualitative analysis of operational practices, workforce engagement, and financial models. Comparative analysis with international best practices informed recommendations for scalable solutions.

### Results and Discussion:

- **Cost Reduction:** Rooftop solar PV systems (500 kW–2 MW) and biomass-based energy solutions reduced factory electricity costs by 20–35%.
- **Emission Reduction:** Renewable energy adoption lowered CO<sub>2</sub> emissions, supporting climate mitigation goals.
- **Operational Resilience:** Microgrid integration and AI-based energy management improved reliability during grid instability.
- **Case Studies – Successful Adoption:**
  - o Hatil Complex Ltd. – Rooftop solar PV installation under IDCOL financing.
  - o Square Textiles Ltd. – Solar PV systems providing cost savings and energy security.
  - o Rancon Industries – Solar PV projects collectively saving millions of BDT annually.
- **Gender and Inclusivity:** Training programs for female workers in system operation promoted workforce inclusivity and technical skill development.
- **International Comparison:** Experiences from Vietnam and India highlight the importance of policy support, financial incentives, and community engagement for scaling renewable energy adoption in industrial sectors.

### Conclusion:

Renewable energy integration in Bangladesh's RMG sector is feasible and beneficial, delivering environmental, economic, and social gains. The study demonstrates cost-effective, low-carbon industrial operations and highlights inclusive workforce engagement. Key challenges include upfront capital costs, regulatory hurdles, and technical capacity gaps. Addressing these requires targeted policies, innovative financing, and capacity-building programs.

## Renewable Hydrogen in Western Australia: How Utilisation, Variability, and Policy Shape Competitiveness

Miss Ayesha Kaleem, Mr Atiq Zaman, Mr Nick Williamson, Mr Sumedha Rajakaruna, Mr Stefan Mero

<sup>1</sup>Curtin University, Bentley, Australia, <sup>2</sup>Australian Gas Infrastructure Group AGIG, , Australia

### **Biography:**

*Ayesha is a PhD student at Curtin University with a Master's in Electrical Engineering. She researches techno-economic pathways for hydrogen deployment and is currently leading the project Green Hydrogen at Home A Sustainable Option for Supplementing Household Energy. Her work integrates engineering, economics, and policy to support future low-carbon energy systems.*

The transition to low-carbon energy systems has renewed global interest in renewable hydrogen, yet its economic viability remains highly sensitive to operational conditions and electricity supply pathways. This study evaluates the cost-competitiveness of hydrogen produced from 5–100 MW PEM and alkaline electrolyzers deployed in Western Australia under three contrasting supply modes. The first two configurations represent grid-integrated operation, where electrolyzers exploit either the lowest-price trading intervals or off-peak periods in the Southwest Interconnected System (SWIS). The third configuration models a fully renewable pathway driven by high-resolution (5-minute) wind and solar data from the Mid-West region.

Across the scenarios, electrolyser utilisation emerges as the strongest determinant of cost outcomes. Grid-connected operation with predefined operating windows of 5,714 and 4,758 hours achieves materially lower LCOH, while offering additional benefits as a flexible load capable of absorbing renewable surpluses. In contrast, the renewable-only pathway exhibits high-cost sensitivity to resource intermittency despite pronounced scale economies. Scenario C's dynamic dispatch leads to base LCOH values ranging from 19–7 \$/kg (PEM) and 14–6 \$/kg (alkaline), which fall further once carbon and oxygen co-product credits are applied. The resulting net costs ( $\approx$ 6.5 and 5.3 \$/kg at 100 MW) remain above WA's industrial gas benchmark, underscoring the continued relevance of long-term policy incentives, learning-induced CAPEX reductions, and strategies that enhance effective utilisation. These findings highlight the operational, regulatory, and scaling conditions under which renewable hydrogen can evolve toward competitiveness within Western Australia's emerging hydrogen industry.

## Reshaping the global geography of heavy industry for net-zero: trade and climate policy

Prof Frank Jotzo

### **Biography:**

*Frank Jotzo is professor of climate change economics and policy at the Australian National University's Crawford School of Public Policy, where he directs the Centre for Climate and Energy Policy. He has advised a number of governments and was lead author in the previous two IPCC assessment reports. He leads projects on decarbonisation including green iron, investment and trade, and policy instruments for low-emissions energy and industrial transition.*

Global decarbonisation, if implemented efficiently, implies large changes in the global geography of energy intensive industrial production. Base commodities like iron and ammonia would be produced where renewable energy is plentiful and cheap, while the traditional industrial centres would retain the higher value-added activities. This is an economic diversification opportunity for resource and energy rich economies that currently export large volumes of fossil fuels, Australia included. Shifting energy intensive production to where renewable energy potential abounds would also help keep a lid on the overall cost of decarbonising the world's resource and industrial supply chains, making global net zero emissions more achievable.

However, the rising agenda of national supply security and nationally focussed green industrial policies in many countries runs counter to efficient global clean industrial transition. What is needed is a level playing field for carbon and industry policies internationally. The best option for this is a system of national carbon prices, complemented by border carbon adjustments.

## Resilience planning – a case for co-optimisation across gas and electricity

Mr Simon Arthur<sup>1</sup>, Mr Logan Page<sup>1</sup>, Mr Jabez Wilson<sup>1</sup>

<sup>1</sup>Endgame Analytics, , Australia

### **Biography:**

*Simon is an energy economist and engineer. He has advised clients on system resilience for both electricity and water, and has seen first-hand during his time as Strategic Planning Lead for the Emirates Water and Electricity Company the challenges of investing in gas infrastructure to support GPG flexibility requirements.*

### Introduction

As electricity grids double down on variable renewable generation (VRE), so too do they heighten their exposure to weather patterns. Rare events with consecutive days of low wind and solar irradiance pose serious threats to energy security in systems lacking backup ‘on demand’ generation. In both the NEM and WEM, planners expect the system to rely heavily on gas-powered generation (GPG) as a cost-effective hedge to ride through renewable droughts. Electricity reliability planning, however, is usually assessed independently of gas supply infrastructure. In practice, sustaining GPG through VRE droughts may require further gas infrastructure investment to ensure both the total availability and flexibility of gas supply — investment market participants may be unwilling to make without reform or government direction.

### Methodology

We build a case for entwined gas and electricity reliability planning in an Australian context by: (i) using statistical analysis to show how cost-effective GPG is at insuring against renewable droughts; (ii) simulating GPG dispatch during such events to examine operational impact on gas supply infrastructure; and (iii) assessing impact on electricity reliability if GPG cannot operate as required due to limits on total or rate of gas offtake.

### Results & Discussion

Preliminary findings suggest GPG offers a low-cost hedge against prolonged low renewable output, particularly post-coal and without alternatives such as geothermal or nuclear power. However, simulations indicate electricity reliability is sensitive not only to aggregate gas availability but also to delivery rate or rate of change constraints. Excluding gas infrastructure from reliability assessments may therefore overstate GPG’s contribution during stress events.

### Conclusions

Our analysis underscores the need for joint electricity–gas reliability planning. Ensuring GPG can operate as needed during renewable energy droughts may require gas infrastructure upgrades, which may in turn require changes to market design or reliability standards. Without coordinated planning or policy intervention, under-investment in gas supply could leave systems more vulnerable than capacity figures suggest.

## Revisiting Wind Energy Potential of Southwest Western Australia using Convection-permitting Regional Climate Simulations

Mr Bikash Devkota<sup>1</sup>, Dr. Jatin Kala<sup>1</sup>, Dr. Kerryn Hawke<sup>1</sup>

<sup>1</sup>Murdoch University, Perth, Australia

### **Biography:**

*Bikash Devkota is a PhD student in the School of Environmental and Conservation Sciences at Murdoch University.*

Electricity produced from renewable sources such as wind and solar has practically zero emissions and is commonly proposed as a climate change mitigation strategy. Southwest Western Australia (SWWA) has one of the best wind resources in Australia. However, detailed estimation of wind energy potential over this sub-region is still missing. In this work, we used data from a Weather Research and Forecasting (WRF) model Version 4.1.2 regional climate model (RCM) at 4 km convection-permitting resolution, driven by data from ERA5 reanalysis to estimate the extractable wind power (EWP) over SWWA and its proximity. The surface wind speed data from convection permitting RCM (CPRCM) was first evaluated against in-situ observations from Bureau of Meteorology at various locations across SWWA and results showed reasonable model skill. The EWP at 100-m was estimated by fitting the power curve from Vestas 3.45 MW (V126-3.45) wind turbine at each grid. The downscaled wind speed shows good agreement with in-situ data in terms of mean bias and wind speed distribution. The Perkins Skill Score (PSS) range from 0.6-0.95 with PSS > 0.8 in majority of the locations. The downscaled ERA5 shows slight underestimation for wind speed in the coastal sites, and the mean bias range from 0.76 m/s to -2.49 m/s in the location with exposure to maritime winds from multiple directions. This is the first time these datasets have been evaluated. As expected, our results show high EWP over the offshore region and off the coast of Bunbury and Fremantle. In summary, our result shows similar spatial patterns for wind power density with global wind atlas and provided the added value of having a high 4 km spatial resolution. This work forms the basis for future studies which will examine how wind and solar resources might change under future climate scenarios.

## Role of Hydrogen Storage in Achieving High Renewable Penetration in the Broome Microgrid

Mr Hadi Amirimoghadam<sup>1</sup>, Prof Ali Arefi<sup>1</sup>, Prof Christopher Lund<sup>1</sup>, Dr Ali Baniasadi<sup>2</sup>

<sup>1</sup>Murdoch University, Perth, Australia, <sup>2</sup>Fortescue, Perth, Australia

### **Biography:**

*Hadi Amirimoghadam is an MPhil candidate in Electrical Engineering at Murdoch University with over 15 years of experience in power system engineering. His research focuses on optimising hydrogen energy storage to enhance the stability and reliability of renewable-rich microgrids using DIgSILENT PowerFactory and Python.*

The Broome Clean Energy Report (2023) illustrated that around 80% of Broome's annual electricity demand could be supplied with renewable energy at a lower cost than continued reliance on LNG generation. Despite this, two key challenges were identified: first, seasonal dependence on LNG during the wet season when solar radiation is low, and second, significant amounts of spilled PV energy during the dry season, when renewable generation exceeds demand. This study shows the original analysis by using hydrogen energy storage as a seasonal balancing mechanism to capture surplus energy and displace LNG generation.

Scenarios were modelled for PV capacities of 40, 50, 60, and 80 MW with 70-, 130-, 160-, and 164-MWh battery, respectively. Based on available spilled energy, hydrogen storage units were sized at 1.14, 1.02, 1.94, and 4.86 MW, respectively. Electrolysers absorb surplus PV generation, and hydrogen fuel cells operate to supply power when PV and batteries are insufficient. The analysis compared monthly and annual LNG demand profiles with and without hydrogen integration.

Baseline gas-only generation required 131 GWh annually. With hydrogen storage, this demand was reduced to zero by utilising 4.86 MW of hydrogen storage in a scenario where the PV is 80 MW and the battery is 164 MWh. The best price is related to the 60 MW PV with 160 MWh battery, without any hydrogen storage, and with adding 1.94 MW hydrogen storage in this scenario, the benefit is 3.1 million dollars annually. Achieved the reduction of 60% in gas generation. Seasonal analysis revealed that hydrogen was particularly effective in the wet season, where gas reliance is typically highest, while also improving utilisation of surplus PV energy in the dry season.

Coupling hydrogen with high PV penetration in Broome's microgrid significantly enhances renewable integration and reduces LNG dependence. Hydrogen storage complements batteries by providing medium-term balancing, supports reliable operation under seasonal variability, and creates a pathway toward more than 90% renewable contribution for Broome at stable long-term costs.

## Role of phase change materials in thermal management for solar photovoltaic systems

Prof Hafiz Muhammad Ali<sup>1</sup>

<sup>1</sup>King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

### **Biography:**

*Dr. Hafiz Muhammad Ali is currently working as an associate professor and director of renewable energy laboratory at Mechanical Engineering Department of KFUPM, Saudi Arabia. He is a recipient of Highly cited researcher award by Clarivate and an editorial board member at journals, notably Journal of Thermal Analysis and Calorimetry.*

Photovoltaic (PV) systems play a major role for energy transition and to shift towards sustainable and renewable energy technologies. Despite being the promising technology, PV systems generally have 15-20% electricity generation efficiency. The performance of PV systems further depends on environmental factors including the adverse effects of heat and high temperatures especially under the harsh conditions of hot climate that may lead to deterioration in the electric output per rise in temperature. To deal with such situations, the proper thermal management is therefore crucial.

Phase change materials is one of the attractive options to provide a passive thermal management with temperature homogeneity across the panels. However, the low thermal conductivity and high energy storage density remain challenging for the mass adoption of such solutions. The use of techniques to enhance thermal properties of phase change materials are adopted over the recent years for effective thermal management solutions.

This presentation will focus on the challenges and opportunities of such materials for better thermal management of photovoltaic systems with an emphasis to reduce the thermal load and to increase the efficiency of the systems optimally.

## Rule-Based Nonlinear Optimization of Brewery Cooling Costs Under Time-of-Use Tariffs Using Interior-Point-Optimizer in MATLAB

Mr Joseph Eminsang Conduah<sup>1</sup>, Professor Kanzumba Kusakana<sup>1</sup>, Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>

<sup>1</sup>Central University Of Technology, Free State, South Africa, Bloemfontein, South Africa

### **Biography:**

*Joseph Eminsang Conduah is a lecturer and doctoral student in Electrical, Electronic and Computer Engineering at the Central University of Technology, Free State, South Africa. Kanzumba Kusakana is a professor and head of the same department, while Olumuyiwa Yinus Odufuwa is a senior lecturer in Mechanical and Mechatronic Engineering.*

Time-of-Use (TOU) electricity rates offer a strategic advantage to lower energy-intensive process operational costs for brewery cooling. In this research, a rule-based nonlinear optimization framework using the Interior Point OPTimizer (IPOPT) MATLAB is presented to reduce the costs of electricity under TOU rates. The refrigeration system is modeled by operational constraints that include compressor capacity, cooling load, and tariff-based scheduling rules. The optimization problem is formulated to minimize total energy cost while ensuring thermal comfort and production requirements. Rule-based logic is used to shift cooling loads from peak to off-peak periods, and IPOPT is employed to solve the resulting constrained nonlinear program. Simulation experiments on synthetic brewery data and Time-of-Use pricing schemes indicate that the proposed method may save up to 35% energy cost without reducing system performance. The research offers an actionable, scalable solution for decreasing the cost of energy in a microbrewery.

## Satellite Observation on Assessing Effect of Greenhouse Gases Emission Reduction with Renewable Energy in UK

Prof Ming Jun Huang<sup>1</sup>, Prof Neil Hewitt<sup>1</sup>

<sup>1</sup>Ulster University, Belfast, United Kingdom

*Biography:*

*TBC*

The UK has set a Net Zero target by 2050, which means no longer adding to the total amount of greenhouse gases in the atmosphere. The two main greenhouse gases (GHGs) are carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). CO<sub>2</sub> is released when oil, gas, and coal are burned in homes, factories, and for transportation, while CH<sub>4</sub> is produced through farming and landfill. Integrating renewable energy for energy supply will be a key solution, especially to find an optimized solution with renewable energy (RE) implementation for power generation to replace fossil fuels.

Regarding CH<sub>4</sub>, agriculture is a major contributor to methane emissions. The effects of reducing greenhouse gases through the implementation of renewable energy sources are complicated and influenced by multiple factors, including geographical area, availability and intermittency of renewable energy sources, peatland CO<sub>2</sub> release, local economy, and policies, etc. It is essential to study the reduction of CO<sub>2</sub> & CH<sub>4</sub> with different renewable energy installations as a comprehensive task and also worth exploring the effects of individual factors.

The World Meteorological Organization (WMO) has established various Global Atmosphere Watch stations worldwide to continuously monitor changes in atmospheric CO<sub>2</sub> and CH<sub>4</sub> concentrations at near-surface levels. To understand the transport mechanisms of global greenhouse gases (GHGs), JAXA launched the Greenhouse Gases Observing Satellite (GOSAT) and GOSAT-2 in 2009 and 2018 to clarify the sources and sinks of CO<sub>2</sub>. NASA put the OCO-2 and OCO-3 satellites into operation.

These satellites provide the ability to retrieve XCO<sub>2</sub>, and their XCO<sub>2</sub> data products have been used to improve our knowledge of natural and anthropogenic CO<sub>2</sub> & CH<sub>4</sub> sources and sinks. The synergistic use of complementary measurements is not only addressing the carbon cycles, but also opens a unique opportunity to address some of the main knowledge gaps in atmospheric CO<sub>2</sub> & CH<sub>4</sub> for the whole area with the prevision of integration of REs. The current work aims at exploiting the synergic measurements together with RE technology implementation and advanced artificial intelligence to quantify the effect of REs in the terrestrial carbon cycle.

## Second-Order Sliding-Mode Observer for DC-Link Voltage Regulation in Grid-tied Inverters under Unbalanced Grid Conditions

Mr Taimoor Muzaffar Gondal<sup>1</sup>, Dr. Asma Aziz<sup>1</sup>

<sup>1</sup>Edith Cowan University, Joondalup, Australia

### **Biography:**

*Taimoor Muzaffar Gondal is a PhD candidate in Electrical Engineering at Edith Cowan University and a postgraduate researcher at CSIRO. His research focuses on advanced inverter control and renewable energy integration. With experience in AI, optimization, and smart grids, he aims to enhance power system stability and resilience.*

The conventional proportional–resonant (PR) controllers are widely adopted in grid-connected inverters but face notable performance limitations under unbalanced grid conditions. These limitations often manifest as reduced stability and oscillatory behavior, which can adversely affect system reliability. To address these challenges, this article presents a comparative study between a second-order super-twisting observer (STO)-based sliding-mode controller and the conventional PR approach. Both controllers are designed and independently implemented in the outer dc-link voltage regulation loop of a three-phase, two-level grid-connected inverter model in MATLAB/Simulink. Simulation results indicate that while the PR controller achieves acceptable steady-state performance, it suffers from oscillations and noticeable deviations in dc-link voltage regulation under unbalanced grid conditions. In contrast, the STO-based sliding-mode controller demonstrates superior transient response, effective disturbance rejection, and closer tracking of the dc-link voltage reference.

The comparative analysis confirms that the STO-assisted sliding-mode strategy provides enhanced voltage regulation capability compared to the conventional PR controller. This study delivers simulation-level validation of both approaches, establishing a benchmark for future experimental investigations and highlighting the potential of observer-based nonlinear control strategies to improve the robustness of grid-tied inverters operating under unbalanced grid scenarios.

## Selecting Winners: Optimising Clean Energy Funding Decisions

Mr Ro Richardson<sup>1</sup>

<sup>1</sup>Department Of Water And Environmental Regulation, Perth, Australia

**Biography:**

*Ro has managed clean energy grant programs for most of his 14 years with WA's environment departments. The \$37 million Clean Energy Future Fund targets high leverage opportunities where grant funding enables success for an innovative project which can then be copied many times, multiplying the benefits.*

Decarbonisation funders require robust methods to select projects with the greatest potential impact. Western Australia's Clean Energy Future Fund (CEFF) supports innovative proposals with strong emissions reduction potential, but found traditional weighted scoring systems to have limitations: projects with major weaknesses—such as low likelihood of success or little need for grant support—could still achieve high overall scores. This study introduces and tests a new multiplicative assessment framework designed to overcome these shortcomings.

The methodology evaluates proposals across three independent dimensions: (1) expected benefits if the project succeeds, (2) likelihood of success with grant support, and (3) likelihood that the grant is needed for success. Scores across dimensions are multiplied, ensuring that a project with a zero in any category cannot be selected. The approach was trialled in a CEFF funding round, supported by a standardised, technology-agnostic financial model template to enable consistent assessment of financial viability, emissions reduction, and energy outcomes.

Results show assessors found the method faster, more intuitive, and easier to adjust if new information emerged. The findings suggest that multiplicative assessment can improve decision-making in clean energy funding programs. Future research should investigate optimal dimension selection, scalability, and adaptation to diverse funding or budget allocation contexts.

## Sodium borohydride hydrolysis for hydrogen export

A/Prof Terry Humphries<sup>1</sup>, Bushra Safdar<sup>1</sup>, Mr Nathan Jones<sup>1</sup>, Dr Peter O Conghaile<sup>1</sup>, Dr Simon Doblinger<sup>1</sup>, Prof. Mark Paskevicius<sup>1</sup>, Prof. Craig Buckley<sup>1</sup>

<sup>1</sup>Curtin University, Bentley, Australia

### **Biography:**

*Terry Humphries is an Associate Professor in Curtin's School of EECMS and a member of the Hydrogen Storage Research Group. With 19 years' experience in hydrogen and energy storage materials, he has published over 85 articles and collaborates globally to advance hydrogen export, thermal storage, and solid-state battery technologies.*

Sodium borohydride ( $\text{NaBH}_4$ ) is a promising hydrogen carrier owing to its high hydrogen density (10.7 wt%  $\text{H}_2$ ), stability under ambient conditions, and compatibility with closed-loop regeneration strategies [1]. Controlled catalytic hydrolysis of  $\text{NaBH}_4$  provides a safe and efficient pathway for on-demand hydrogen release of up to 21.4 wt%  $\text{H}_2$ , contingent on the development of durable, low-cost catalysts and scalable reactor designs.

A variety of hydrolysis catalysts have been designed to optimise hydrogen generation rates (HGR) [2]. Noble metal-based materials are highly effective but inhibited by cost, and so transition metal based catalysts have been explored. Cobalt based catalysts have been found to be effective with HGR rates of 10 L/min/gcatalyst having been reported with reusability tests confirming stable performance over multiple hydrolysis cycles. To facilitate large scale hydrolysis, reactors have been developed to facilitate continuous operation [3]. These systems must control hydrogen delivery with minimal pressure fluctuations, and scaling projections indicate compatibility with industrially relevant purification and hydrogen compression.

This presentation discusses advances in cobalt-based catalyst systems and a prototype flow-through reactor for continuous hydrogen generation. These advances not only enhance the practicality of  $\text{NaBH}_4$  for hydrogen export but also complement emerging electrochemical regeneration pathways for converting spent borates back to  $\text{NaBH}_4$ . Integration of catalyst, reactor, and regeneration technologies establishes a feasible framework for  $\text{NaBH}_4$  hydrogen supply chains, supporting global energy transport and decarbonisation strategies.

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## Stability Analysis of Guy-Wire Supported Floating Offshore Wind Turbines: Preliminary Study on Flexible Platforms

Dr Sharath Srinivasamurthy<sup>1</sup>, Dr Shigeo Yoshida<sup>1,2</sup>, Dr Kazuhiro Iijima<sup>3</sup>, Dr Yasunori Nihei<sup>4</sup>

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### **Biography:**

*Assistant Professor at the Institute of Ocean Energy, Saga University, Japan*

Floating Offshore Wind Turbines (FOWTs) are emerging as one of the frontrunners in the renewable energy market due to its high potential. Various concepts of FOWTs have been proposed and developed over the past decade and feasibility tests are underway. One of the main challenges for practical implementation of FOWTs is to achieve stability of the support structure consisting of the tower and floating platform, and increase the efficiency of the power production. This study explores the use of stiffened guy-wire to increase the stability of the support structure. To this end, it essential to model the support structure as a flexible body and understand the interactions of the tower and the floating platform with the stiffened guy-wires. The flexibility of the floating platform is considered by modelling them as a number of hull elements connected by beam elements. The inertial properties including the hydrostatics and hydrodynamics are modelled within the hull element, and structural properties are modelled within the beam element. As a first step, a semi-submersible platform is considered and modelled as a flexible body to understand and verify the dynamic behavior of the flexible platform. The guy-wires are then modelled as pre-tensioned ropes connecting the tower top to the floating columns of semi-submersible in the present study. The response of the flexible platform is obtained under combined wind and wave loads with and without stiffened guy-wires. The preliminary results show the potential use of guy-wires to increase the stability of the FOWT. With this analysis technique, it is possible to understand the mutual interactions of tower, floating platform and stiffened guy-wires in real time. It will also aid in analysis and design efficient guy-wires to obtain lighter and compact floating platforms.

## Sustainability, Gender, Equity, and Inclusive Transition in Bangladesh

Dr Md. Hemayet Hossain<sup>1</sup>

<sup>1</sup>Risda-Bangladesh, Savar, Dhaka, Bangladesh

### **Biography:**

*Md. Golam Mostafa, with 27+ years in development, is Director (Enterprise Development & Fundraising) at RISDA-Bangladesh. He specializes in livelihoods, skills development, climate resilience, OHS, gender inclusion, and organizational capacity building, with extensive experience in donor engagement, program design, and international assignments in Sri Lanka, India, and Thailand.*

### Abstract – Sustainability, Gender, Equity, and Inclusive Transition in Bangladesh

#### Introduction:

Bangladesh is highly vulnerable to climate change, experiencing frequent floods, cyclones, riverbank erosion, and saltwater intrusion. These hazards disproportionately impact women, children, and marginalized communities, especially in coastal zones and char areas (World Bank, 2022).

Concurrently, Bangladesh is pursuing renewable energy deployment to meet rising energy demand and achieve net-zero emissions by 2050. This study examines strategies for a gender-responsive, equitable, and climate-resilient energy transition that ensures sustainability, social inclusion, and community participation.

#### Methodology:

A mixed-method approach was adopted, including literature review, case studies, and secondary data collection from IDCOL, GIZ, RISDA, and local communities. Analyses focused on renewable energy access, gender participation, community governance, and livelihood outcomes. Comparative assessment with international practices informed recommendations for scalable, inclusive interventions.

#### Results and Discussion:

- **Energy Access & Gender:** Solar Home Systems (SHS) in Khulna and Satkhira trained women as technicians and energy monitors, improving adoption and household resilience (IDCOL, 2022).
- **Equity & Community Ownership:** Microgrid projects in Jamuna and Padma char islands supplied over 5,000 households, with  $\geq 40\%$  female representation in governance committees (GIZ, 2021).
- **Livelihoods:** Solar-powered irrigation, dryers, and cold storage facilities supported women-led enterprises and small farmers, enhancing climate-adaptive income stability (RISDA, 2023).
- **Policy & Governance:** National Renewable Energy Policy and Gender Action Plans foster female participation and community engagement, though challenges remain due to limited budgets, technical capacity gaps, and monitoring deficiencies.
- **Opportunities:** Gender-responsive financing, digital monitoring tools, and public-private partnerships can scale inclusive renewable energy deployment and climate-resilient livelihoods.

#### Conclusion:

Inclusive renewable energy deployment in Bangladesh strengthens climate resilience, promotes social equity, and supports livelihoods for vulnerable populations. Integrating gender, community participation, and social inclusion into planning and governance ensures that energy transitions are both sustainable and just. Addressing challenges such as financing, technical capacity, and policy implementation can further enhance equitable outcomes. Bangladesh's experience offers a model for the Global South, demonstrating that climate action and social justice can advance together.

# Sustainable Life Cycle Management of Sedimentary Basins for Critical Minerals and Hydrogen in Eastern DRC

Mr Shaloom Mbambu Kabeya<sup>1,2</sup>, Professor Janny Ciabembi Mukendi<sup>1</sup>

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## **Biography:**

*Shaloom Mbambu Kabeya*

*Architect and environmental engineer with a Master's in Social Innovation Design. He focuses on sustainable construction, circular economy, and energy valorization of sedimentary basins in Central Africa.*

*Janny Ciabembi*

*Professor and mechanical engineer specializing in energy transition. She develops innovative solutions for low-carbon energy production in Africa*

## Introduction

The sedimentary basins of Eastern Democratic Republic of Congo (DRC) are rich in critical minerals essential for global clean energy technologies. Beyond their extractive potential, these basins offer significant opportunities for carbon capture and storage (CCS) and geological hydrogen development—key components of the global decarbonization agenda. This research proposes a systems-level approach to managing these basins sustainably, integrating extraction, carbon storage, and hydrogen production.

## Methodology

An integrated Life Cycle Assessment (LCA) framework was applied to evaluate the environmental impacts of both mineral extraction and subsurface energy applications. The study used high-resolution geological data and remote sensing to map basin stratigraphy and identify zones of interest. A GIS-based multicriteria analysis combined sedimentological modeling with geophysical and environmental parameters to pinpoint suitable zones for CCS and hydrogen storage. Key indicators such as greenhouse gas emissions, land use, and water consumption were assessed across the basin's full resource lifecycle.

## Results and Discussion

The results indicate strong potential for multi-functional use of the basins, with zones compatible for both critical mineral extraction and low-carbon energy initiatives. Strategic integration of CCS and hydrogen systems with existing or planned mining infrastructure can significantly lower the carbon footprint of industrial operations. The approach supports spatial and policy alignment with national energy and climate strategies while ensuring environmental safeguards.

## Conclusion

Eastern DRC's sedimentary basins can be leveraged not only as mineral reserves but as strategic energy assets that support the DRC's transition toward low-carbon development. Coordinated lifecycle planning and infrastructure integration are crucial to achieving this vision. This study highlights the potential for a paradigm shift from resource extraction to sustainable subsurface management, supporting climate goals and industrial development.

## Technical and economic feasibility of hydrogen utilization to replace diesel in remote area: decarbonization scenario

Dr Khotimatul Fauziah<sup>1</sup>, Ms Yuli Astriani<sup>1,2</sup>, Mrs Asih Kurniasari<sup>1</sup>, Mr Toha Zaky<sup>1</sup>, Mr Kurniawan Kurniawan<sup>3</sup>, Dr Abdul Hamid Budiman<sup>1</sup>, Dr Arif Darmawan<sup>1</sup>, Dr Zainal Arifin<sup>4</sup>, Mr Rodzi Gusti Akbar Sarjana<sup>4</sup>, Dr Agus Setiawan<sup>4</sup>, Prof Eniya Listiani Dewi<sup>5</sup>

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### **Biography:**

*She received B.Eng. degree in electrical engineering from Institut Teknologi Sepuluh Nopember and M.Eng. from Universitas Indonesia. She completed Dr.Eng. degree from Shizuoka University. Currently, she is a researcher at the National Research and Innovation Agency, Indonesia. Her research interests include renewable energy, hybrid systems, microgrids, monitoring and control systems.*

A hybrid microgrid system based on renewable energy (RE) in remote areas could reduce fuel costs for diesel-based generators (DGs) while lowering emissions. Hybrid microgrids with RE generators are typically equipped with batteries for energy storage, addressing the intermittency problem. Utilizing hydrogen in microgrids will solve seasonal or long-term storage problems that batteries cannot provide. This research investigates the feasibility of integrating hydrogen and fuel cell systems to reduce DGs fuel costs in remote areas in East Nusa Tenggara, Indonesia. Various scenarios are presented combining DG, solar photovoltaic (PV), battery energy storage system (BESS), proton exchange membrane fuel cells (PEMFC), hydrogen tanks, and PEM electrolyzers with various capacities. This study uses HOMER Pro software to find the optimum configuration for minimizing generation costs and environmental impacts. The findings show that integrating hydrogen technology in small-scale microgrids requires a much larger PV capacity due to the relatively lower efficiency of both electrolyzer and fuel cell. Consequently, this strategy results in an almost twofold increase in the levelized cost of energy (LCOE) compared to the existing system. Moreover, the relationship between fuel cell efficiency and CO<sub>2</sub> emission reduction is linear, with fuel cells operating at 80% efficiency resulting in more CO<sub>2</sub> reduction compared to those at 40% or 60% efficiency. Finally, the study highlights that changes in CO<sub>2</sub> emissions are predominantly influenced by the size of the PV capacity, as renewable microgrid power sources rely solely on PV generation.

## Techno-Economic Analysis of a Renewable Energy based Hydrogen-Battery Off-Grid Microgrid

Mrs Nusrat Chowdhury<sup>1</sup>, Dr GM Shafiullah<sup>1</sup>, Dr Martina Calais<sup>1</sup>

<sup>1</sup>Murdoch University, Murdoch, Australia

### **Biography:**

*Nusrat Chowdhury is a Ph.D. researcher at Murdoch University specializing in hydrogen-integrated microgrids. Her research focuses on renewable energy systems, energy storage, and hybrid microgrid optimization, contributing to improved system reliability, enhanced storage performance, and progress toward low-carbon energy transitions.*

**Abstract:** The growing need for resilient and low-emission energy infrastructures has increased attention towards renewable-integrated microgrids supported by green hydrogen technologies. In off-grid regions, the variability of renewable resources necessitates dependable long-duration storage to maintain continuous power supply. Batteries are effective for short-term storage, whereas hydrogen enables extended storage by converting excess electricity into hydrogen through electrolyzers, which can be utilized in fuel cells. This study investigates hybrid energy systems integrating photovoltaic (PV), batteries (BT), fuel cells (FC), electrolyzers (EL), hydrogen tank (HT) and diesel generators (DG) for remote Australian communities. Five system types are evaluated: Type 1: PV/DG/BT, Type 2: PV/BT, Type 3: PV/BT/EL/HT/FC, Type 4: PV/DG/EL/HT/FC, and Type 5: PV/BT/EL/HT/FC/DG. The simulations and the optimization are performed using the HOMER Pro software, evaluating key technical indicators including renewable fraction, excess energy, unmet load, and storage autonomy, together with economic metrics including the Levelized Cost of Energy (LCOE), and Net Present Cost (NPC). The findings demonstrate that the PV/BT/EL/HT/FC/DG configuration (2857 kW PV, 320 kW DG, 7728 kWh battery, 500 kW electrolyzer, 200 kW fuel cell, 923 kW converter, 800 kg hydrogen tank) provides the most promising outcome, achieving 98.3% renewable fraction, reduced diesel use, high autonomy, an LCOE of \$0.512/kWh, and an NPC of \$19.44M, with a significant reduction in CO<sub>2</sub> emissions (42,958 kg/year). The study underscores the value of integrating both hydrogen and battery storage to enhance reliability, limit dependence on fossil fuels, and support cost-effective decarbonization in off-grid microgrids.

## Techno-economic and environmental feasibility of a Wind-Hydrogen-CHP microgrid for industrial decarbonisation in Teesside, UK

Mr Ammar Ahmed Wafad

<sup>1</sup>Nottingham Trent University, Nottingham, United Kingdom

### **Biography:**

*Ammar Ahmed Wafad is a sustainable energy engineer with an MSc in Sustainable Energy Engineering from Nottingham Trent University. His work centres on renewable energy system modelling, techno-economic and environmental assessment, industrial wind-hydrogen microgrid design, and energy systems optimisation, supported by previous technical roles in MLWD engineering and project management.*

Industrial decarbonisation has been one of the most stringent and complex challenges in achieving net-zero compliance with global energy transition targets. The chemical and process industrial cluster in Teesside, United Kingdom, a high-priority industrial decarbonisation region, faces this challenge due to its reliance on natural gas CHP and grid imports. The study explores the feasibility of a hybrid renewable energy microgrid (HREM) using a wind-hydrogen and combined heat and power (CHP) system to support an uninterrupted energy supply. The study aims to use a technoeconomic and environmental assessment approach to investigate the HREM's feasibility, operational robustness, and decarbonisation potential.

An open-source energy modelling framework is developed in Python for Power System Analysis (PyPSA) to simulate an hourly dispatch across an entire year under variable circumstances. The HREM incorporates wind turbines, an electrolyser, hydrogen storage, a hydrogen-fueled CHP plant with an industrial heat capture and mix mechanism combining captured and generated heat to meet heat demands, and a reliable battery energy storage system for uninterrupted supply. A Monte-Carlo simulation is incorporated to produce probabilistic system performance KPIs comprising carbon emissions and levelised energy costs to assess HREM's real-world applicability. Furthermore, a lifecycle assessment (LCA) is performed to evaluate the environmental impact of the system's infrastructure deployment.

The study evaluates the technoeconomic and environmental feasibility of the designed system for meeting consistent industrial loads by eliminating reliance on fossil fuels. Moreover, the framework is optimised for economic competitiveness using realistic benchmark scenarios. The uncertainty analysis justifies a parametric approach to investigate HREM's financial and environmental performance, encompassing operational resilience and risk profile. A grid-only benchmark configuration is identified for an extensive comparative analysis to provide HREM's emission reduction capacity and contribution to the UK's industrial decarbonisation targets.

The research provides a strong, comprehensive, and applicable solution and recommendations to support future decision-making for the UK's industrial decarbonisation planning with replicability across various energy-intensive clusters within the UK and globally. The probabilistic approach justifies an evident insight into HREM's viability, risks, and policy relevance concerning the integration of wind-hydrogen and CHP technologies. The designed methodological framework also indicates reproducibility and expanded multi-cluster analyses.

## Techno-Economic Evaluation of a Solar–Wind–Battery Hybrid Energy System for Reliable Renewable Power Supply

Mr Abdus Samad Azad<sup>1</sup>, Dr. Nahina Islam<sup>1,2</sup>, Dr. MD Nurun Nabi<sup>1</sup>, Dr. Shaminda De Silva<sup>1</sup>

<sup>1</sup>School of Engineering and Technology, Rockhampton, Australia, <sup>2</sup>Centre of Machine Learning, Networking and Education Technology (CML-NET), Norman Gardens, Australia

### **Biography:**

*Abdus Samad Azad received his B.Sc. in Computer Science and Engineering from the IIUC, Bangladesh, and his M.Sc. from Universiti Teknologi PETRONAS, Malaysia. He is currently pursuing a Ph.D. at Central Queensland University. His research interests include renewable energy optimization, metaheuristic algorithms, deep and machine learning applications.*

The increasing integration of distributed renewable energy sources, particularly solar photovoltaics (PV) and wind power, presents technical and economic challenges in achieving stable and cost-effective energy systems. This study evaluates the techno-economic feasibility of a hybrid renewable configuration integrating solar PV, wind, and battery energy storage components. Using HOMER Pro, three system architectures were simulated and optimised based on Net Present Cost (NPC) and Levelized Cost of Energy (LCOE) under realistic meteorological and load conditions. The optimal configuration—comprising approximately 404 kW of PV capacity, seven G10 wind turbines, and one modular lithium-ion battery with about 31 hours of autonomy—achieved a 100% renewable fraction with an NPC of approximately \$2.60 million and an LCOE of \$0.886 per kWh (USD). Annual energy production reached around 662 MWh from PV and 75 MWh from wind, while the battery contributed through short-term energy balancing with an annual throughput of about 110 MWh. The system maintained stable operation, with the battery state of charge ranging primarily between 60–100% throughout the year. The analysis confirmed that increasing storage beyond the optimal size provided limited economic improvement, underscoring the efficiency of a PV-dominant system complemented by moderate wind generation and minimal storage.

## The clean energy transition in Australia cannot and will not happen without First Nations

Ms Rebecca Halliday, Ms Carol Martin, Ms Kate Finlayson

With over 60% of energy projects likely to be developed intersecting First Nations lands, First Nations involvement is not optional—it's foundational.

Our recent report with EY, *Investor benefits of First Nations participation in clean energy projects*, demonstrates the mutual benefit of investing with First Nations groups in clean energy development to enjoy faster approvals, access to capital pools, and social licence, and reduced risk, cost and delay. At the same time, First Nations leaders and groups around the country are determined to participate in and share the economic benefits derived from clean energy projects impacting their land through mechanisms including co-ownership, equity stakes, preferential contract bidding, and revenue sharing.

As a result of increasing First Nations determination and investor interest, and emerging government incentives, there are now a number of clean energy project partnerships in development proposing sophisticated participation models with First Nations groups such as equity investment, revenue sharing, co-development, and other agreements which ensure First Nations groups have a level of control and/or ownership over project design, development and outcomes, an important driver of long-term success, leading to a reduced risk of project abandonment, lower investment risk, and great economic benefit.

Simply, investing with First Nations makes good business sense.

So how to go about it? The First Nations Clean Energy Network's *Building Capacity of Proponents* toolkit resets the standard. It was created to equip proponents, governments and investors with the guidance needed to engage First Nations early, meaningfully, and on equal terms, offering clear, practical guidance leading to strong agreements, shared equity, and benefits for all.

The common theme in this sessions is about moving beyond compliance towards meaningful engagement, strong partnerships and mutual benefit.

## The fastest rollout of energy in human history

Prof Ray Wills<sup>1</sup>

<sup>1</sup>Future Smart Strategies, Perth, Australia, <sup>2</sup>University of Western Australia , Nedlands, Australia

### **Biography:**

*Professor Ray Wills is a diversely experienced researcher, academic, consultant, adviser, executive, business owner, author, commentator, entrepreneur and futurist with a focus on sustainability and technology. His work has covered disruptive technology in most sectors. Ray is recognized internationally in Top 100 Global Leaders in Sustainability, Climate Change and Energy.*

Achieving decarbonisation will require widespread electrification and a 100% renewable energy (mostly wind and solar) powered grid, supported by the rapid roll-out of battery storage. Electrification enables the replacement of fossil fuels with clean electricity from renewable sources across diverse locations:

I will present my decade-old Future Smart model and compare past projections to present projections for a decarbonised future of energy and infrastructure and key areas of the economy focused on electrification of processes using currently available clean tech.

Recent reports of solar being the fastest energy transition in human history was anticipated by my model in 2015, and presented at WREC 2017. I will show model projections continuing as projected beyond 2025 to 2030 and beyond. In 2025 the tipping points on climate appear much closer than those on a fossil fuel exit and large emissions reductions from renewable energy bringing the reductions climate needs.

## The impact of a thin ventilated air gap on the ActiVer system performance

Dr Dominika Knera<sup>1</sup>, Prof. Dariusz Heim<sup>1</sup>, Dr Anna Wieprzkowicz<sup>1</sup>

<sup>1</sup>Lodz University of Technology, Lodz, Poland

### **Biography:**

*Dominika Knera is an assistant professor at Lodz University of Technology in Poland. She performs research in the areas of photovoltaic integrated with building envelope, modelling of solar radiation, heat and mass transfer, energy systems and building performance simulation. She takes part in national and international research projects.*

Building integrated photovoltaic (BIPV) facades are promising solutions for introducing renewable energy sources into the built environment. The primary goal of this study is to analyse the energy and temperature performance of the photovoltaic facades characterized by limited ventilation and consequently limited heat dissipation. The ActiVer system considered in this paper is constructed as lightweight, flexible photovoltaic panels bonded to the façade elements. They can be easily installed on any concrete or cement wall surface without the need for heavy substructures as is the case with typical facade cladding systems. The main challenge identified in development of ActiVer is the problem of PV panels overheating due to high solar radiation absorption and limited heat emission from the system.

The analysis was performed using numerical software ESP-r which is a comprehensive, state-of-the-art integrated building performance simulation suite. It comprises several applications to model heat, air, moisture, light and electrical power flow at user specified spatial and temporal resolution. The air movement in air gap is modelled as an air flow network coupled with energy balance.

Numerical analysis allowed for the comparison of various BIPV façade solutions, including the geometry of the air gap (which influences different ventilation rates) and the design of the outer layer containing the PV panel (a single PV panel or one equipped with an additional stiffening surface). Calculations were performed for Central European climate conditions, intermittent climate (Dfb to Koppen-Geiger), for annual simulations. The analysed BIPV façade was oriented south to get the extreme solar radiation gain and the electrical output of the PV panels. The results included the thermal behaviour of the ActiVer system, the possibility of reducing the temperature of the photovoltaic cells through ventilation, and the electrical efficiency of the PV panels depending on their temperature. Compared to a lightweight BIPV façade without a ventilation gap, the temperature of the proposed ActiVer system was lower in all analysed cases. Consequently, the ActiVer system produce more electricity year-round. Furthermore, it can be observed that the additional stiffening surface adjacent to the PV panel increases its temperature and reduces its electrical efficiency.

## The Missing Pieces of the Puzzle: Industrial Decarbonisation Opportunities in the Global North and South

A/Prof Atiq Zaman<sup>1,2</sup>, Mr Benjamin Gazeau<sup>2</sup>, Dr Henrique Pacini<sup>3</sup>

<sup>1</sup>Global South Nexus, Perth, Australia, <sup>2</sup>Curtin University, Perth, Australia, <sup>3</sup>UN Trade and Development, Geneva, Switzerland

### **Biography:**

*Associate Professor Dr Atiq Zaman is an internationally renowned expert in circular economy and sustainability, and the Founding Co-Director of the Global South Nexus. He holds several research leadership roles, including a Member of the United Nations Council of Engineers for the Energy Transition.*

Achieving global net-zero targets is critical to limiting temperature rise to 1.5 °C and addressing climate change. Heavy industries are central to this challenge, as they are highly resource- and energy-intensive and account for a significant share of global greenhouse gas emissions. However, industrial decarbonisation faces substantial socio-economic, technical, and regulatory barriers. As net-zero is a global objective, meaningful transitions must occur in both the Global North and the Global South.

Using a Global North case study, this paper examines decarbonisation pathways in Australia's brick manufacturing industry through a life-cycle assessment (LCA) of alternative fuel-switching options. The results indicate that emissions from brick production could be reduced by over 50% through a transition from natural gas to biomethane, and by up to two-thirds relative to the baseline through full solar electrification.

For the Global South, the study investigates the decarbonisation potential of Bangladesh's textile industry through advanced wastewater treatment and reuse. The findings demonstrate that wastewater reuse presents significant opportunities for emissions reduction. Under a scaled-up scenario, treating and reusing only 25% of the industry's current wastewater could contribute approximately 4–7% of Bangladesh's nationally determined contribution (NDC) decarbonisation targets.

By integrating insights from both Global North and Global South contexts, this study identifies overlooked yet impactful decarbonisation opportunities in heavy industries. It highlights the role of circular-economy interventions in accelerating the transition to net zero. The paper concludes with evidence-based policy recommendations to support scalable and context-sensitive industrial decarbonisation strategies.

## The Quest for Genuine Green Architecture in Contemporary Developments

**Prof Derya Oktay**<sup>1</sup>

<sup>1</sup>Fenerbahçe University, Istanbul, Turkey

***Biography:***

*Professor Derya Oktay is an architect, urban designer, researcher, and educator, and currently serves as Dean of the Faculty of Architecture and Design at Fenerbahçe University, Istanbul, Turkey. Her latest academic work focuses on sustainable urbanism and architecture, building on visiting researcher appointments at the University of California-Berkeley, the University of Michigan, and Oxford Brookes University. She has extensive experience in qualitative and empirical research supported by the EU, USAID, TÜBİTAK, and EMU, and has published widely in international books, journals, and conference proceedings. She is Editor-in-Chief of Ekistics and the New Habitat and serves on the editorial boards of leading international journals. She has been recognized with the WREN Pioneer Award and is among the world's top scientists, according to Stanford University's multidimensional impact research.*

Green architecture is widely recognised but often misunderstood and misused. This paper critically examines these misleading claims and defines genuine green architecture as designs that prioritise energy efficiency, resource conservation, and the integration of renewable energy. Through case studies and empirical data, this paper compares authentic sustainable buildings with those that merely appear eco-friendly and proves that it's possible to develop genuine green buildings by reinterpreting the local authentic cases. The paper emphasises the need to move beyond superficial environmentalism and adopt a transparent, science-based approach. It advocates for stricter green building certification standards and a clearer, more precise definition of sustainable architecture - one that is climate-responsive, ethical, and focused on achieving real environmental impact rather than simply creating an illusion of sustainability.

## The Role of EVs in the energy transition

**Prof William Grace**<sup>1</sup>

<sup>1</sup>University Of Western Australia, Crawley, Australia

### ***Biography:***

*Bill Grace is a sustainability adviser, researcher and consultant, and an Adjunct Professor at the University of Western Australia's Australian Urban Design Research Centre (AUDRC). His research encompasses climate change and the energy transition in the context of urban systems.*

### Introduction

The energy transition will involve interaction between household electrification, household self-supply through solar PV and batteries, electric vehicles (EVs) and the electricity grid. That interaction will influence the magnitude and electricity demand patterns of this system over time and will determine the supply response of the electricity grid. This study seeks to explore the potential scenarios arising from household preferences and policy associated with the energy transition.

### Methodology

The study is based on development of a system dynamics model which facilitates the exploration of a range of plausible future scenarios arising from interaction and feedback between household energy and mobility choices and the changing electricity network, including the time-of-use price of network electricity.

### Results and Discussion

The study is in progress and only preliminary results are available at the time of writing. The likely penetration of EVs could have a major influence on the self-supply of households as battery capacity is significantly larger than for stand-alone batteries. Outcomes will depend on the ability of EVs to act as household batteries and policies for household electricity export to the grid including from vehicle-to-grid (V2G). In turn electricity savings could reduce payback periods for EVs. The net demand for network electricity from households varies significantly from the range of possible scenarios, both in respect of total demand and demand patterns.

### Conclusions

The future of the electricity grid is sensitive to interactions and feedback associated with household choices such as electrification, self-supply and EVs. These choices in turn are dependent of government policy and incentives, reflecting the need for policies on all these elements of the system to be integrated.

## The Role of LDES in a highly decarbonised NEM

Mr Logan Page, Ms Olivia Filipe, Mr Simon Arthur

<sup>1</sup>Endgame Analytics, , Australia

### **Biography:**

*Logan Page is a Principal at Endgame Analytics.*

*His experience focuses on modelling firming and LDES assets in Australia, including major projects for ARENA, Hydrostor and Synergy on optimal portfolios to manage renewable drought risk in highly decarbonised energy markets.*

*He holds a MCom (Economics) from Victoria University of Wellington.*

### Introduction

As the National Electricity Market (NEM) moves towards net-zero emissions and higher penetrations of variable renewable energy (VRE), the grid will increasingly require capacity capable of dispatching over long periods of time to manage coincident low periods of renewable output (commonly known as renewable droughts) and provide seasonal energy shifting.

Longer-duration energy storage (LDES), technologies such as flow batteries, thermal storage or compressed air energy storage have emerged as a credible set of technologies to provide these services to the grid but have a different set of opportunities and risks compared to shorter-duration storages (such as Lithium-Ion BESS).

An understanding of the value of these emerging technologies from a systems perspective is required to underpin future investment and policy-making decisions.

### Methodology

We conduct a techno-economic assessment of the NEM, under very-high penetrations of VRE to test how access to LDES at certain cost inflection points (\$/kW, CAPEX) changes the least-cost development pathway of the NEM and the operation of the fleet over the next 15 years, under a range of credible scenarios.

We quantify whether there are material reductions in total systems costs and emissions stemming from access to low-cost LDES technologies in the NEM.

### Results

At certain cost thresholds, the model sees large uptakes of LDES candidates with consequent reductions in total system costs and emissions. However, outcomes vary considerably across scenarios. In some cases, little or no LDES capacity is deployed, highlighting the sensitivity of outcomes to underlying future conditions such as levels of decarbonisation.

### Conclusions

While the deployment of LDES is not universal across scenarios, even modest adoption provides a measure of insurance against credible risks to system resilience and deployment of other technologies. This de-risking role underscores the strategic importance of LDES in supporting the resilience and flexibility of the future NEM.

## Thermochemical Synergy: Coupling Ionic Liquid-Based Absorption Refrigeration with Solar Thermal Systems for Net-Zero Cooling

Dr Olumuyiwa Yinus Odufuwa<sup>1</sup>

<sup>1</sup>Central University Of Technology Free State, Bloemfontein, South Africa

### **Biography:**

*Dr Olumuyiwa Yinus Odufuwa is a Senior Lecturer in Mechanical/Mechatronic Engineering, specialising in refrigeration systems, thermal energy storage, and digital pedagogy. He integrates constructivist teaching, simulation tools, and research-based learning to inspire future engineers. His work bridges theory and practice, fostering innovation, integrity, and graduate attributes in higher education.*

This article suggests a new combination of ionic liquid-based vapour absorption refrigeration systems (VAS) with solar thermal power to provide environmentally friendly, low-emission cooling solutions. Starting with the ammonia-water cycle scenario, the study redesigns the thermodynamic arrangement with new refrigerants such as ionic liquids and deep eutectic solvents that provide improved safety, tunability, and environmental efficiency. The research formulates a solar-thermal absorption hybrid system, performs dynamics analysis of heat transfer, and exergetic efficiency comparison with traditional systems. The method is a simulation of heat exchanger geometry, refrigerant flow rates, and solar collector integration using MATLAB and EES. A 15–25% increase in COP and a 40% decrease in GWP relative to ammonia-based systems are the findings. This research contributes to the development of net-zero cooling technology and towards energy system transformation into climate-resilient energy systems.

## Towards a Just Transition: Renewable Energy for Fisheries-Based Rural Communities in Indonesia

Mrs Dannya Maharani Putri Utami<sup>1</sup>, Mr Hari Solagrati<sup>2</sup>, Mr Aditya Perdana Putra Purnomo<sup>3</sup>, Mrs Penny Hestianti Marsella<sup>4</sup>, Prof Christopher Lund<sup>5</sup>, Prof Tania Urme<sup>5</sup>, Mr Muhammad Saladin Islami<sup>5</sup>  
<sup>1</sup>National Research And Innovation Agency (BRIN), South Tangerang , Indonesia , <sup>2</sup>Climate Policy Initiative (CPI), Jakarta, Indonesia, <sup>3</sup>Community Energy Toolkit (COMET), Jakarta, Indonesia, <sup>4</sup>State Electricity Company of Indonesia (PT PLN), Jakarta, Indonesia, <sup>5</sup>School of Engineering and Energy, Murdoch University, Perth, Western Australia

### **Biography:**

*Dannya Maharani, researcher at BRIN since 2022, focuses on microgrids and renewable energy systems, holds Master in Energy Systems Engineering.*

Most of the remote fisheries communities in developing countries rely heavily on diesel generators particularly to power cold storage and ice-making facilities that needed to preserve the raw fishes. Diesel based electrification systems poses major challenges specially for its high emission characteristics. With high fuel costs due to geopolitical issues, vulnerability to price fluctuations and transportation to remote areas electricity, threaten the economic sustainability of fishing communities.

This study examines the transition from diesel to renewable energy in a remote fisheries communities of Eastern Indonesia, aligned with PLN's Diesel Replacement Program (DRP) and the national target of reducing carbon emissions by 32% by 2030. The study applies a Multi-Criteria Decision Analysis (MCDA) framework using the Simple Additive Weighting (SAW) method to evaluate and prioritize potential sites for diesel replacement. The criteria include fisheries economics (such as catch volume and market value), accessibility (transport and grid connectivity), and the balance between fish catch and preservation capacity.

Laiwui in Maluku Province was identified as the most suitable site. The analysis integrated renewable energy potential assessment, system sizing sensitivity tests, and a just energy transition framework to evaluate direct, indirect, and induced socioeconomic impacts. A techno-economic evaluation also conducted which revealed that a hybrid microgrid configuration comprising a 7.2 MW PV system, a 0.46 MW diesel generator, and a 15.11 MWh BESS, offers the optimal solution. This configuration achieves a cost of energy of \$0.206/kWh, substantially lower than the base case of \$0.333/kWh and nearly equivalent to diesel generation costs in Halmahera, while achieving a renewable fraction of 94.81%. It also reduces carbon emissions by 99.5% and eliminates heavy reliance on diesel fuel, underscoring both economic and environmental viability. The novelty of this study lies in extending the Just Energy Transition framework from coal to diesel power plants, explicitly linking renewable deployment to fisheries productivity and community welfare. The findings provide a replicable roadmap for scaling up DRP across Indonesia's archipelagic regions, with future research needed on scalability and long-term socioeconomic outcomes.

## Towards Net Zero: Policy and Financial Frameworks for Hydrogen Development in Bangladesh

Mr . Muhammad<sup>1</sup>

<sup>1</sup>IUT, Gazipur - 1704,, Bangladesh

### **Biography:**

*Received M.Sc. degree in Electrical and Electronics Engineering from IUT, Dhaka. Accolade Professional Certificate in "Clean Power" from Imperial College London. Participated in ICEPAG2020 colloquium at the University of California, Irvine. Attended the IEEE WIE International Leadership Summit (ILS'18). Successfully coordinated the short course in 2020 themed on SDG 7.*

Green hydrogen is increasingly recognised as a critical enabler for deep decarbonisation, energy security, and industrial transformation (IRENA, 2022; IEA, 2023). Globally, advanced economies have developed hydrogen strategies, but Bangladesh—facing rising fossil fuel dependence, limited fiscal space, and high climate vulnerability—has yet to define a comprehensive hydrogen roadmap (Government of Bangladesh, 2023; World Bank, 2022). This lack of strategic direction presents a governance and financing challenge that risks excluding Bangladesh from emerging hydrogen value chains in Asia. The research question guiding this study is: What policy, financial, and governance mechanisms are required to enable Bangladesh's hydrogen transition in line with its net-zero ambitions?

The study adopts a mixed-methods approach combining qualitative and quantitative analyses. National policy documents, including the Integrated Energy and Power Master Plan and Mujib Climate Prosperity Plan, were critically reviewed to assess hydrogen's positioning in Bangladesh's energy transition (Government of Bangladesh, 2023; V20/Government of Bangladesh, 2022). A SWOT framework was applied to evaluate governance readiness and financing barriers (CPD, 2023). Comparative benchmarking with Japan, Australia, India and EU hydrogen strategies (World Bank, 2023) provided regional and global context.

The analysis reveals three key findings. First, governance fragmentation across ministries constrains coordinated hydrogen policy-making. Second, the absence of financial incentives—such as green bonds, concessional loans, and risk-sharing mechanisms—limits investor confidence. Third, regulatory gaps in hydrogen standards and safety hinder market development. Despite these barriers, modelling suggests Bangladesh's coastal zones (e.g., Matarbari) could achieve competitive production costs (<USD 3/kg by 2035) if supported by international finance and technology transfer (JICA, 2023). Stakeholder highlights the need for a dedicated hydrogen policy unit and stronger public–private partnerships, consistent with regional lessons (UN ESCAP, 2023).

This study contributes by framing Bangladesh's hydrogen transition as a governance and finance challenge rather than solely a technical one. Findings underscore the importance of embedding hydrogen into net-zero planning through integrated policy frameworks, catalytic finance, and multilateral cooperation. Limitations include reliance on preliminary cost estimates and stakeholder perceptions, which require further validation. Future research should expand techno-economic modelling under dynamic market conditions and explore hydrogen's role in transport and fertiliser decarbonisation.

## Transitioning from Coal: A Techno-Socioeconomic Study of Renewable Energy Integration in Thailand's Power Sector

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<sup>1</sup>Murdoch University, Murdoch , Australia, <sup>2</sup>Climate Analytics, Fremantle, Australia

### **Biography:**

*Koki Baba recently obtained a master's degree in renewable and sustainable energy at Murdoch University, Australia. His graduate thesis at Murdoch focused on energy transition in emerging economies with Professor Tania Urmee. In July 2025, he joined Climate Analytics to gain practical experience towards a future career.*

The electricity sector plays a vital role across the world by owning the largest share of coal-fired capacity, which increases the complexity of techno-socioeconomic and slows the progress of the transition away from coal. As existing studies heavily focus on technical feasibility and cost trajectories of renewables, a significant knowledge gap exists in understanding both the technical limitations and socio-economic impacts of coal phase-out. The Kingdom of Thailand presents a compelling case for transitioning from coal to renewable energy due to its significant carbon neutrality commitments, abundant renewable resources, and the pressing need to reduce reliance on fossil fuels to achieve carbon neutrality by 2050. As the coal supports its developing economy at the regional level, recognising the gaps in techno-socioeconomic dynamics of coal phase-out is required to achieve the ambitious target through a just transition. This study focused on the country's last coal region, Lampang Province in Northern Thailand, where the Mae Moh Power Plant and coal mine are located. The province faces barriers within the power sector, local economy, and social implications through coal retirement, which emphasises the need for developing a just transition plan. Techno-socio-economic analysis was conducted based on desktop research and energy system simulation on the Low Emission Analysis Platform (LEAP) software. The scenario-based simulations evaluate feasible transition pathways and showcase the importance of developing a comprehensive and just transition plan that balances energy security, economic viability, and social equity in the long run. The primary capacity installations are projected to occur in two stages to minimise the impact of capacity retirements in 2030 and 2049. Each transition phase will require approximately 377.2 MW by 2030 and 964.6 MW by 2049, with a total investment of 736.6 million USD. As the risk of economic and social impacts is expected to be significant during the transition, integrating technical, economic, and social dimensions into the analysis contributed to identifying the key limitations and opportunities in the emerging economy. This study provides evidence-based insight for policymakers and highlights the importance of inclusivity in designing transition pathways.

## Turning Obligation into Opportunity on the Path to Net Zero

Mr Dominic Da Cruz<sup>1</sup>

<sup>1</sup>Zenith Energy, , Australia

### **Biography:**

*Dominic Da Cruz brings 20 years of experience in leadership roles within the energy sector, shaping strategies and developing markets for sustainable energy across both public and private sectors. As CEO and project director, he has led numerous clean energy and microgrid projects spanning utilities, government, resources, and commercial sectors.*

This presentation explores the journey of the Australian Independent Power Producer (IPP), Zenith Energy, in transforming its portfolio and transitioning from fossil fuel reliance to renewable energy leadership. It explores Zenith's strategic shifts, innovative approaches, and impactful decarbonisation.

The presentation examines Zenith's commitment to net zero emissions by 2035 and its proactive measures to embed decarbonisation into its corporate strategy and governance framework. From effective stakeholder communication, transparent commitments, and strategic collaborations, Zenith has navigated the net zero challenge and established itself as a market leader in high fraction renewable energy power systems.

Key topics covered include Zenith's investment in industry collaboration for decarbonisation, innovative financing tied to decarbonisation goals, and sector-leading engagement with First Nations communities to facilitate meaningful participation of Aboriginal people in the energy transition, ensuring equity and inclusivity.

This presentation will highlight how a focus on increasing enterprise value has been the secret of successfully navigating a path to net zero. A focus that enabled innovation, growth, and resilience. Shape

Key learnings from this presentation

- \*Strategies for effectively communicating and integrating energy transition goals into corporate strategy and governance.
- \*Insights into innovative financing mechanisms and industry collaborations for decarbonisation.
- \*The impact of inclusive engagement with Indigenous communities in the energy transition.
- \*Net Zero can be more effectively achieved when managed as a strategic enabler of enterprise value creation instead of compliance.
- \*Practical examples of the path to net zero with renewable energy and a 2030 interim milestone horizon.

# Uncertainty Quantification (UQ) for AI-Driven Predictive Maintenance of Large-Scale Solar PV and Battery Storage

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## **Biography:**

*Vijith Kartha is a Senior Engineering Manager at rProcess with 10+ years of experience, delivering 5,200+ energy projects globally across residential, C&I, and utility-scale sectors.*

*He specializes in design optimization and leading teams to drive digitalization using AI, geospatial, and data-driven solutions for optimal design, asset optimization, and centralized operations.*

## Introduction

Large-scale solar PV and battery energy storage systems (BESS) face operational variability from environmental factors, component degradation, and system uncertainties. Traditional reactive or fixed-schedule maintenance leads to unplanned downtime, inefficiencies, and reduced asset life. BESS, in particular, requires continuous 24/7 monitoring and rapid fault diagnosis due to its complex chemistry, thermal sensitivity, and high operational risk. This study presents an AI-driven predictive maintenance framework leveraging Uncertainty Quantification (UQ) of key performance parameters to proactively identify risks, optimize maintenance schedules, and enable continuous 24/7 monitoring and diagnosis of solar PV and BESS assets.

## Methodology

The framework integrates multi-source data, including SCADA measurements, environmental sensors, and historical operational logs. Key parameters - PV module output, inverter efficiency, battery state-of-charge, and thermal behavior - are modeled probabilistically to quantify uncertainty. Monte Carlo simulations, sensitivity analysis, and stochastic modeling identify variability and critical risk factors. An AI predictive model, trained on UQ-enhanced features, forecasts performance degradation, detects early fault signatures, and recommends proactive maintenance actions. AI-enabled digital twins simulate scenarios, validate predictions, and support centralized 24/7 monitoring across distributed assets.

## Results and Discussion

The AI-UQ framework identifies parameters most susceptible to variability and potential failure, enabling targeted, timely maintenance. Probabilistic modeling combined with AI reduces reliance on manual inspections and fixed schedules, minimizing downtime and operational risk. Digital twins integrated with SCADA provide a continuous 24/7 operational view, supporting real-time fault detection, early anomaly diagnosis, and predictive analytics for both solar PV and BESS. Compared to traditional methods, the framework improves reliability, asset utilization, and operational efficiency while providing actionable insights for maintenance prioritization and resource allocation.

## Conclusion

Uncertainty Quantification combined with AI transforms predictive maintenance of large-scale solar PV and BESS. By enabling continuous 24/7 monitoring and proactive diagnosis, the framework minimizes downtime up to 30%, reduces risks, and optimizes maintenance scheduling. While initial AI model training and UQ setup require investment, long-term gains in efficiency, reliability, and asset performance are substantial. Future work will explore automated maintenance execution, real-time fault diagnostics, and portfolio-level optimization across hybrid renewable energy assets.

## Unlocking High Energy Efficiency in Vanadium Redox Flow Batteries through Laser-Modified Graphite Electrodes

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<sup>1</sup>King Fahd University Of Petroleum & Minerals, Dhahran, Kingdom of Saudi Arabia

### **Biography:**

*Iqbal Azka Al Hamid, from Indonesia, is a master's student in Materials Science and Engineering at KFUPM. His research centers on redox flow batteries, focusing on electrode modification through advanced surface engineering. He aims to contribute to energy-storage innovation and the development of sustainable electrochemical technologies.*

All-vanadium redox flow batteries (VRFBs) are promising for large-scale energy storage due to their safety, long cycle life, and scalability. Given the inner sphere nature of redox reactions involved, their performance is limited largely due to the poor electrochemical activity of electrodes, which makes the electrode modification quite important. This study presents an effective strategy to address these limitations by employing CO<sub>2</sub> laser treatment to modify graphite felt electrodes. VRFB cells with laser-treated electrodes displayed higher discharge capacities and energy efficiencies across current densities of 25–100 mA·cm<sup>-2</sup> compared to pristine electrodes. The optimized electrode-based cell achieved ~95% energy efficiency at 25 mA·cm<sup>-2</sup> and maintained ~75% at 100 mA·cm<sup>-2</sup>, significantly outperforming the untreated counterpart. Long-term cycling tests confirmed excellent stability, with ~90% capacity retention and nearly 100% coulombic efficiency after 100 cycles. This study establishes laser-guided electrode engineering as an effective route to enhance VRFB performance and scalability.

## Virtual Power Plant Coordination and Local Aggregator Modelling towards Indonesia's Electricity Market Transformation

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### **Biography:**

*Abdul is an Indonesian researcher with 15 years of experience in energy and power systems, specializing in infrastructure design, planning, and operation modeling. He leads bottom-up approaches to accelerate net-zero emissions, focusing on readiness and impact for developing nations at regional and national scales.*

Indonesia's planned electricity market transformation - driven by the energy transition and the development of the new capital city, Nusantara - presents a strategic opportunity to integrate distributed energy resources (DERs) through advanced coordination mechanisms. Virtual Power Plants (VPPs), operated via local aggregators, can consolidate diverse DER portfolios into dispatchable, market-ready capacity, enabling operational flexibility and greater penetration of clean, green, and low-emission (CGLE) electricity-generated sources. This study develops and evaluates a VPP coordination and local aggregator model tailored to Indonesia's regulatory and infrastructural context of the main administrative area known as kawasan inti pusat pemerintahan (KIPP), focusing on overcoming the limitations of the current single-buyer market structure. The framework combines a quasi-dynamic simulation language (QDSL) and soft-coupled modelling capable of processing sub-minute discrete data for interactive power flow execution. This approach captures rapid fluctuations in DER output and demand, allowing near-real-time optimization of dispatch schedules, ancillary services, and grid stability through locally aggregated VPP's scenario. The model architecture includes three tiers: (i) DER owners or investors - such as rooftop solar, battery energy storage systems, electric vehicles, and responsive loads; (ii) local aggregators - handling forecasting, optimization, and bid formation; and (iii) the grid operator - interfacing with wholesale markets and system operations. Simulation scenarios, calibrated with the typical load and representative generation profiles for Nusantara, show that coordinated VPP operation can cut peak demand by up to 17.76%, decrease dependency from centralized fossil-powered plant by 38.72%, and compensate the grid emission factor by over -22.35% compared to baseline operation. The quasi-dynamic execution allows the aggregator to respond to daily supply and demand events in the KIPP area, enhancing grid stability regulation and voltage support. Policy analysis indicates that achieving these benefits will require targeted reforms: establishing a regulatory sandbox for VPP pilots, introducing dynamic pricing and ancillary service remuneration, and standardizing data exchange protocols to ensure interoperability. The findings suggest that Nusantara could serve as a national testbed for fostering decentralized market mechanisms, providing scalable lessons for Indonesia's broader electricity sector.

## Virtual Power Plants for Clean Energy Transition: Policy, Regulation, and Practice in Australia and Globally

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### **Biography:**

*Hemlal Bhattarai is PhD student at ECU with research focus in power and energy studies. Before commencing his doctoral studies, he was working as an Assistant Professor and Dean at RUB, Bhutan. He has authored several papers and also active reviewer for the indexed journals.*

Renewable and clean energy technologies are rapidly transforming the global energy sector and research landscape. With robust plans, targets, and commitments aligned with climate imperatives, immediate action from the energy sector is critical, given its contribution to approximately 74% of annual global emissions. The accelerated integration of Distributed Energy Resources (DER) is playing a pivotal role in power systems, signalling promising progress. However, this transition necessitates that power sector stakeholders optimize existing infrastructure with minimal interventions while addressing persistent challenges. Among the most promising advancements is the rapid development and deployment of Virtual Power Plants (VPP). Australia has emerged as one of the global examples in VPP implementation, consistently demonstrating progress; nevertheless, evidence indicates that effective policy and regulatory frameworks are essential for realizing the full potential of VPP. The primary objective of this study is to synthesize key learning from Australia's VPP initiatives and identify targeted interventions to enable a level playing field for VPP as drivers of the energy transition and compare the experiences with global practices. Insights derived from multiple Australian VPP case studies and its comparisons offer a comprehensive understanding and actionable recommendations for policymakers and regulators to facilitate the timely and holistic deployment of VPP.

## WA South West Interconnected System Energy Modelling towards 100% Renewables

Mr Fraser Maywood<sup>1</sup>

<sup>1</sup>Sustainable Energy Now, Perth, Australian

### **Biography:**

*Fraser Maywood (MSc, GAICD) has over forty years' experience in the international Oil & Gas industry. He has also worked in the power and mining sectors.*

*Fraser has been a SEN member since 2021 and the chair for the past three years.*

### Introduction

Western Australia's main grid the South West Interconnected System is undergoing a rapid transition from mainly fossil fuelled generation to majority renewable energy generation.

There is much debate about the optimum energy mix and this paper sets out the options and how they might be realised in public energy policy.

### Methodology

Sustainable Energy Now (SEN) modelling team use publicly available data covering generation assets, demand forecast and in-house modelling tool SIREN to generate an energy model.

A number of scenarios can be simulated and sensitivity analysis undertaken to understand the available pathways and alternatives.

### Results and Discussion

From a benchmarking perspective SEN's modelling produces similar results to those published by the Government. However, SEN's modelling allows a number of different scenarios to be considered which could provide greater benefit to the households, communities and industry.

### Conclusion

SEN's modelling highlights that only 13% of available rooftop solar connected to the SWIS is utilised – by optimising the amount of battery backed rooftop solar with flexible exports, dynamic operating envelopes and suitable rewards for customer participation in the energy market, the amount of large-scale renewable energy development and associated transmission infrastructure can be optimised.

A simplified approach is used for generation location and transmission capacity - the energy model could be extended to better reflect the transmission network.

## Waste-to-Energy for Sustainable Development In Burundi

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<sup>1</sup>EcoWaste Solutions Burundi, Bujumbura, Burundi

### **Biography:**

*Duchesse Relly Nshimirimana, Founder and CEO of EcoWaste Solutions Burundi. Passionate about social impact, she creates sustainable waste and energy solutions that uplift communities, protect the environment and contribute to Burundi's Journey towards a cleaner, more resilient and inclusive future.*

Burundi faces a growing challenge in managing urban and rural waste, which threatens both public health and the environment. With limited infrastructure and awareness, much of the waste ends up in open dumps or is burned, releasing harmful emissions. This study explores how Waste-to-Energy (WTE) strategies can provide sustainable solutions to Burundi's waste crisis while contributing to energy access and environmental protection. The objective is to identify feasible WTE models that align with the country's socio-economic realities and ecological priorities.

A mixed-method approach was adopted combining field data collection, stakeholder interviews and literature review. Quantitative and qualitative data were obtained through semi-structured interviews with 25 participants, including community leaders, waste workers and policymakers across three provinces: Bujumbura-mairie, Gitega, and Ngozi. Three WTE models were evaluated: biogas production from organic waste, small-scale incineration with energy recovery, and plastic-to-fuel conversion. Each model was assessed using a sustainability framework that included technical viability, economic feasibility, environmental impact, and social acceptance.

The analysis revealed that organic waste accounts over 65% of municipal waste, making biogas the most promising WTE option. Pilot simulations showed that decentralized biogas systems could provide cooking fuel to over 500 households per commune while reducing landfill use and methane emissions. However, challenges such as limited technical capacity and funding gaps persist. Incineration showed moderate potential in urban centers, but concerns about emissions and operational cost remain. Plastic-to-fuel conversion, while innovative, requires further study due to its complexity and regulatory uncertainty. Community feedback emphasized the need for awareness campaigns and local involvement in project design.

The study highlights biogas as a viable entry point for sustainable waste to energy in Burundi. WTE can simultaneously address waste accumulation, energy scarcity, and environmental degradation. Future work should focus on capacity building, pilot project implementation, and public-private partnerships. Addressing policy gaps and ensuring community ownership will be critical to long-term success.

## Wave-Induced Motion in Modularized Catamaran FPV System with Hinged Connections under Catenary Station-keeping Condition

Mr Mohammad Izzuddin Jifaturrohman, Prof I Ketut Aria Pria Utama, Dr Dendy Satrio, Dr Teguh Putranto, Dr Luofeng Huang

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### **Biography:**

*I Ketut Aria Pria Utama is a professor of marine hydrodynamics at the Institut Teknologi Sepuluh Nopember in Surabaya, Indonesia. He is a fellow of the Indonesian Academy of Sciences (AIPI). His research interests include the performance of high-speed craft and submarine bodies, and the development of ocean renewable energy.*

The modularized catamaran floater for floating photovoltaic systems (CFPV) presents an innovative solution to the challenges of limited land availability and high land acquisition costs associated with traditional solar panel installations. As global energy demand continues to grow, nations are increasingly competing to harness clean energy from renewable energy devices (RED). CFPV presents an efficient and scalable alternative by utilizing floating platforms to capture solar energy over marine surfaces, even in challenging environments. The system is supported by a buoyant floater design and structural stool, which elevates the solar panels, making it suitable for near-shore energy generation. A noteworthy feature of this design is its multi-array modularized concept, which allows for scalable floaters to maximize the potential of marine spaces, enhancing the energy harvesting capacity. However, the motion performance of these multi-array systems is crucial, especially under wave-induced motions. The multi-body concept introduces more complexity in hydrodynamic assessments compared to single structures. This study focuses on an FPV system with hinged connections under dynamic catenary station-keeping conditions using Linear Potential Flow Theory (LPFT) and 3D Panel Diffraction, simulated in the numerical environment of ANSYS AQWA with idealized fluid assumptions. The study investigates the combined effects of rotational stiffness in hinged connections and their interaction with the axial stiffness of mooring cables. By analyzing these factors under the JONSWAP wave spectrum, this study evaluates the time-domain hydrodynamic response. It is hypothesized that increasing the rotational stiffness of the hinged system and mooring lines reduces the motion excitation, both vertically and rotationally. On the other hand, if motion is minimized, the tension in the mooring lines increases to accommodate small displacements of the structure. Therefore, these two aspects must be carefully considered during the design phase to ensure that the structure does not undergo excessive excitation and that the mooring line tension meets safety requirements.

## What is a 'Net Zero' Precinct?

Dr Hugh Finn<sup>1</sup>, Angelina Bowden-Jones

<sup>1</sup>Curtin University, Perth, Australia

### **Biography:**

*Dr Hugh Finn is the Technical Lead (Certification) for the RACE for 2030 CRC Pathways to Net Zero Precincts project, and a Lecturer at Curtin Law School.*

### Introduction

Precinct-scale decarbonisation is critical for the built environment to transition to net zero. However, what constitutes a 'net zero precinct' is unclear.

A claim that a precinct is 'net zero' must be supported by a quantitative inventory of emissions within a system boundary and demonstrate alignment with an authoritative definition of 'net zero'.

We developed two working definitions for 'net zero precinct', using carbon accounting and life cycle assessment frameworks.

### Methodology

We used the definition of 'net zero' in PAS2080: 2023 Carbon Management in Buildings and Infrastructure, which emphasises reducing emissions to zero, or to a residual level that is consistent with reaching net zero emissions in eligible 1.5°C emissions pathways, with removals being used to neutralise any residual emissions.

We used the lifecycle stages in the environmental impact standards EN 15978 and EN 17472 to establish system boundaries for operational carbon (emissions from operational energy + water) and for whole life carbon (all emissions across the precinct life cycle). We also integrated user carbon and beyond lifecycle carbon stages.

### Results and Discussion

We defined net zero precinct for operational carbon as a precinct that achieves a state of balance between operational carbon emissions and removal of emissions from the atmosphere through emissions reductions within the precinct and from the net annual export of energy from onsite renewables and removals within the precinct or elsewhere. This balance is achieved at a point in time in the precinct's operation and is sustained thereafter.

We defined a net zero precinct for whole life carbon as a precinct that achieves a state of balance, across its whole lifecycle, between emissions and removal of emissions from the atmosphere through emissions reductions within the precinct, from the net annual export of energy from onsite renewables; and beyond the precinct from the reuse, recycling, or recovery of materials, and removals within the precinct or elsewhere.

### Conclusion

These working definitions will be refined based on industry feedback. The definitions provide guidance for what urban precincts will look like at net zero and how to evaluate claims that precincts have achieved, or aligned with, net zero.