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ABSTRACT BOOK

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Keynote Presentation

Que Vadis Domine – on Future Retrofitting Residential Buildings

Mark Bomberg[1*], David Yarbrough[2], Umberto Berardi[3], and Paulo Santos[4]

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Abstract

A unified approach for the next generation of new and retrofitted residential buildings is based on four decades experience of passive housing in North America and almost three in the EU. Before the SAR coV 2 pandemic, Europe and America differed in their main approaches to indoor air handling in residential buildings. The pandemic, however, revealed shortcomings in both approaches and a need for improvement. The authors propose a merger of these approaches. Obviously, some details will be tailored to accommodate the climate differences but the success with regard to covid infection in interior spaces must be as good as that for outdoor spaces.

The authors analyze heating, cooling and ventilation aspects of housing and propose a unified technology called a generic name Environmental Quality Management (EQM). New elements in this technology are:

1) Introduction of a two-stage construction process for both new and retrofit cases, that modifies patterns of financing. In the first stage, the best possible performance within a prescribed investment limit is the objective; in the second stage, reduction of the cost of the required energy efficiency level is the objective.

2) A building automatics controls utilization of thermal mass that also includes a geothermal storage linked with solar panels trough hydronic system and heat pump. One implements the concept of adaptable indoor climate as well as a full integration of HVAC with the building structure. This is accomplished with assistance of a monitoring and performance evaluation (MAPE) system. Introducing automatics to the design process offers improved integration of building subsystems and introducing energy optimization in the post-construction stage.

3) A subset of this technology is Environmental Thermo-Active (ETA) technology developed specifically for retrofitting projects

The ETA is a result of improvements already applied in practice to reinforce the role of a triangle: occupant-controlled comfort, energy efficiency and interaction of buildings with smart energy grid as the driving force of progress.

Keywords: energy efficiency; building automatic control; field energy use; two-stage construction process; cost-benefit evaluation; affordable retrofit of residential buildings

Charging Batteries for Renewable Energy Using Light-mediated Photoelectrochemical Reactions

Christopher S. Johnson

Argonne National Laboratory, Lemont IL USA

Abstract

The application of photochemistry in battery materials science is an emerging new topic of study. Previous results have shown that the impedance of the battery can be dramatically lowered during charging when light (LED or white light) is irradiated onto the electrode interface [1]. The lowering of resistance is due to creating more charge carriers in the case of semi-conducting materials and speeding up electron exchange between metal centers and cation diffusion for intrinsically insulating compounds [2]. This operation is done during potentiostatic voltage hold of the electrochemical cell. This phenomenon has been observed in many Li-ion battery cathode materials such as spinel LiMn2O4, spinel LiNi0.5Mn1.5O4, and LiFePO4. In addition, charging graphite (LiC6) or Li4Ti5O12 anodes also display lower resistance and more rapid Li intercalation. In this talk, I will spotlight this work and put it within context of renewable energy and the role it may play in leveraging energy storage for solar processes. [1] A. Lee, et al., "Photo-accelerated fast charging of lithium-ion batteries", Nat. Commun. (2021) 10, 4096 [2] J. Lipton, et al., "Correlating wavelength dependence on LiMn2O4 cathode photo-accelerated fast charging with deformations in local structure", Cell Reports Physical Science (2022),

Biography

Christopher S. Johnson is currently an Argonne Distinguished Fellow and senior chemist at Argonne National Laboratory, specializing in the research & development of battery materials and battery systems with 31 years of experience. He is known worldwide for his development of state-of-art lithium-ion battery cathode materials, and recently, Si anodes, and sodium-ion batteries. He has published over 134 publications, and 25 issued US patents. He has received the battery research award from the International Battery Association in 2006. He is the 2018 recipient of the University of Chicago Argonne Distinguished Scientist Award, and is a Fellow of the Electrochemical Society.

Oral Presentation

Study on Form-stable Composite Metallic Phase Change Materials

Geng Qiao[1]*, Chaomurilige[1] and Gaoqun Zhang[2]

[1]Global Energy Interconnection Research Institute Europe Gmbh, Germany; [2]State grid smart grid research institute Co.Ltd

Abstract

This study investigated five combinations of metallic phase change materials, namely Al-Si/C, Al/C, Zn/C, and Al-Si/Al2O3, synthesized through a hybrid sintering method which encased one metal as phase change material in one supporting material. Investigations on various aspects of the materials were conducted, including thermophysical properties, strength, cycle performance, material structure, and composition. The Al-Si/Al_2O_3 combination exhibited promising performance, demonstrating high latent heat value, compatibility, strength, energy density, specific heat capacity, and thermal cycling stability. The manufacturing process and formulation of the selected pair was optimised by adjusting the mixture uniformity, material composition, additives, pressing strength, sintering temperature, and other parameters. After 50 cycling tests, a mass loss of 10% was found

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after 30 cycles and no significant mass loss occurs thereafter. The yield pressure reached 44 MPa. The latent heat remained above 140 kJ/kg after the cycling test. This research demonstrates the features of Al-Si/Al_2O_3 composite metallic phase change material and discusses the perspective fields of application scenarios.

Two Dimensional Nanocomposite Functional Materials for Sustainable Energy Storage Applications

R. Jayavel

Anna University, Chennai, India

Abstract

Two dimensional (2D) nanostructures are emerging futuristic materials for energy storage applications because of its unique properties with excellent functionality. The study of decorating the 2D sheets with inorganic functional materials such as metals, metal oxides and metal sulfides is now becoming a promising and challenging area for energy storage devices. In this study, reduced graphene metal-oxide composites with SnO_2, CeO_2, TiO_2, RuO_2 have been synthesized by homogeneous co-precipitation method [1]. The structural aspects of graphitic carbon have also been explored for energy storage applications. The structural properties of natural graphite, graphene oxide, graphene-metal oxide composites were studied. The prepared composite structure has been subjected to optical, electrical, and electrochemical property studies. The electrochemical properties of graphene-metal oxide composites reveal that these materials can be effectively used for supercapacitor application with improved specific capacitance, higher power density, energy density and cyclic stability [2]. Multi-layered composite structures with 1 D carbon nanotubes integrated with 2 D graphene structures with the addition of 3 D bulk nanoparticles were prepared with improved properties [3]. Coin cell supercapattery device using nickel cobaltite nanostructures as a cathode material has been developed for energy storage applications Heterostructures of different 2D materials have also been fabricated to improve the electrochemical performance.

High-Temperature Thermochemical Heat Storage by Complex Transition Metal Hydrides

Shahrouz Nayebossadri

University of Birmingham, Edgbaston, Birmingham, UK

Abstract

Thermochemical heat storage systems are highly efficient with significantly higher energy density (5-10 times higher energy density than known sensible heat and phase change materials) and no energy degradation in time, lower volume requirements, without requirements for thermal insulation and good adaptability for a greater range of practical applications. Therefore, reversible thermal energy storage via thermochemical reactions is currently regarded as the most promising emergent technology in which research and development are required to address these systems' complexity and higher investment costs. Metal hydride-based thermochemical heat storage is considered a promising stand-alone system for medium and long-term heat storage. The application of these systems will be technically and economically feasible if their energy density and conversion efficiency from heat to electricity are improved by increasing the operating temperature. Complex transition metal hydrides have been studied as hydrogen storage materials but rarely for their heat storage properties[1]. Their high thermodynamic stability and high energy density make them very promising materials for thermal energy storage at high temperatures. As a result, Mg_2FeH_6

compound with a high gravimetric hydrogen density of 5.5 wt % has been subject to greater scrutiny as a heat storage material. Here we demonstrate the possibility to enhance the operation temperature of Mg_2FeH_6 almost by 70 °C (from 300 to 370 °C) via partial Co substitution in $[FeH_6]^{4-}$ anion complex and its effect on the thermal energy storage of the material.

Biography:

Shahrouz Nayebossadri research is focused on the physical chemistry of materials, which covers a wide range of topics related to developing novel energy production and storage materials. I am developing materials for thermochemical heat storage, metal hydrides for stationary and mobile hydrogen storage and hydrogen compression, novel crystalline and amorphous bulk and thin-film metallic materials for hydrogen purification and sensing, and hydrogen-assisted processing routes for recycling rare-earth elements. My broad expertise in materials science is also applied to a range of applications including fuel cells, batteries, catalysis, carbon capture, heating & ventilation, heat transportation, and waste heat recovery.

Mn_3O_4-NiFe Layered Double hydroxides (LDH)/Carbon Composite Cathode for Rechargeable Zinc-air battery

L K Nivedha*, V Maruthapandian , R Kothandaraman

Indian Institute of Technology Madras, India

Abstract

Rechargeable zinc-air batteries (ZAB) are gaining significant research attention owing to their high energy density and copious zinc resources worldwide. However, the unsolved obstacles such as dendrites, passivation, depth of discharge and the lack of an efficient cathode catalyst restrict their practical application. By and large, non-noble transition metal-based catalysts are well-reputed materials for catalysing oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) with greater stability in alkaline medium. Herein, we report the synthesis and application of Mn3O4-NiFeLDH/Carbon composite as a cathode catalyst for rechargeable ZAB. The synergetic effects of the mixed transition metals (Mn/Ni/Fe) have aided in catalysing ORR and OER in alkaline electrolyte with a shallow potential gap of 0.7 V. The composite, by its distinctive physicochemical characteristics, shows an excellent OER activity with a current density of 1.5 mA cm-2 at a potential of 1.6 V and a superior ORR activity with an onset potential of 0.8 V when compared with their counterparts. Nevertheless, the catalyst prefers a twoelectron pathway for the electrochemical reduction of oxygen which results in a limiting current density of 2.5 mA cm-2 . The bifunctional activity of the Mn3O4-NiFeLDH/Carbon composite was utilized in developing rechargeable ZAB. The fully fabricated ZAB delivers an open circuit voltage of 1.4 V, a peak power density of 70 mW cm-2 and a specific capacity of 800 mAh g-1 at a current density of 20 mA cm-2 with an average discharge voltage of 1 V and the cell is operable upto 50 mA cm-2 . Rechargeable ZAB demonstrated over 110 h at 10 mA cm-2 . Further, the cause for the diminished charge-discharge performance experienced beyond the 100th cycle was investigated and carbon corrosion was testified using Infrared spectroscopy.

Biography:

I am Nivedha. I obtained my master's degree in chemistry from the National Institute of Technology (NIT), Trichy. I am pursuing my doctoral studies in electrochemistry at the Indian Institute of Technology (IIT) Madras, India. My research area involves developing Zn-based secondary battery technologies like Zinc-Air and Zinc-Bromine systems for storing renewable energies. One of my works on zinc-air battery was recently awarded third prize in the New Generation Ideation Contest

(NGIC-22) held by Hindustan Petroleum Corporation Limited (HPCL), Bangalore.

Design of Layered Cathode and Electrolyte for Improved Sodium-ion Batteries

Jae Yoon Sung and Chang Woo Lee*

Kyung Hee University, South Korea

Abstract

Sodium-ion batteries have attracted a lot of attention due to abundant resources and environmental-friendly advantages. However, further improvements are needed to commercialize sodium-ion batteries for poor air-stable property of cathodes and flammable risk of electrolyte.

In this work, the stability of the anode to air and moisture and the thermal stability of the electrolyte are importantly considered in designing materials in battery chemistry. In order to find out the reason for improved electrochemical properties of the attempted cell, morphology and components of the cathode-electrolyte interphase (CEI) layer are characterized by morphological and spectroscopic studies, compared to a cell comprising a carbonate-based electrolyte.

Biography:

Prof. Dr. Chang Woo Lee is a Professor of Chemical Engineering and Director of the Center for the SMART Energy Platform at Kyung Hee University in South Korea. He received his Ph.D. degree in Chemical Engineering from the Illinois Institute of Technology, USA and formerly B.S. & M.S. degrees from Kyung Hee University. He worked as a Senior Researcher at Korea Electrotechnology Research Institute (KERI) before joining the University in 2006. His research interests are in energy materials science and engineering, especially in the field of electrochemical energy storage and conversion.

A High-Performance Phenazine Based Cathode for Aqueous Organic Zinc-Ion Battery

Priya Vallayil[1]*, Kothandaraman Ramanujam[2], Sethuraman Sankararaman[3]

Indian Institute of Technology Madras, Chennai, India

Abstract

Aqueous Zinc-ion batteries are very appealing for massive energy storage applications due to their inherent safety, low cost, and longevity. Nevertheless, the lack of positive electrode material (cathode) caused by the slow diffusion of Zn^{2+} inside solid inorganic frameworks is impeding their advancement. Organic electrode materials have recently been endorsed as a less-toxic and environment-benign substitute for traditional inorganic electrode materials. Even though, its performance is hampered by the poor rate capability and limited cycle life caused by cathode material deterioration during Zn^{2+} insertion/de-insertion. An efficient charge-discharge in aqueous zinc ion batteries, even at high current densities with good capacity retention, is made possible by the stability of aromatic organic heterocyclic cathode materials with the necessary intermolecular spacing. Herein, we describe a strategy to utilize a commercially available redox-active organic molecule (ROM), Phenazine (PNZ) derivative, which can offer efficient and reversible Zn^{2+} storage due to its high molecular symmetry with low molecular weight. The use of a cation exchange membrane and optimization of the volume of the electrolyte and conductive carbon enabled the PNZ electrode to provide a better specific capacity value of 247 mAh g^{-1} (90% of the theoretical capacity of PNZ) at 1 A g^{-1} with a good capacity retention of 75 % over 300 cycles. These results

indicated that exceptional water insolubility in small organic molecules like PNZ would make them a desirable electrode material for AZIBs. In contrast to conventional design ideas for organic electrode materials such as having a larger molecular weight or adding certain polar functional groups to the organic molecular bulk, our research offered fresh and insightful recommendations for the creation of simpler organic electrodes.

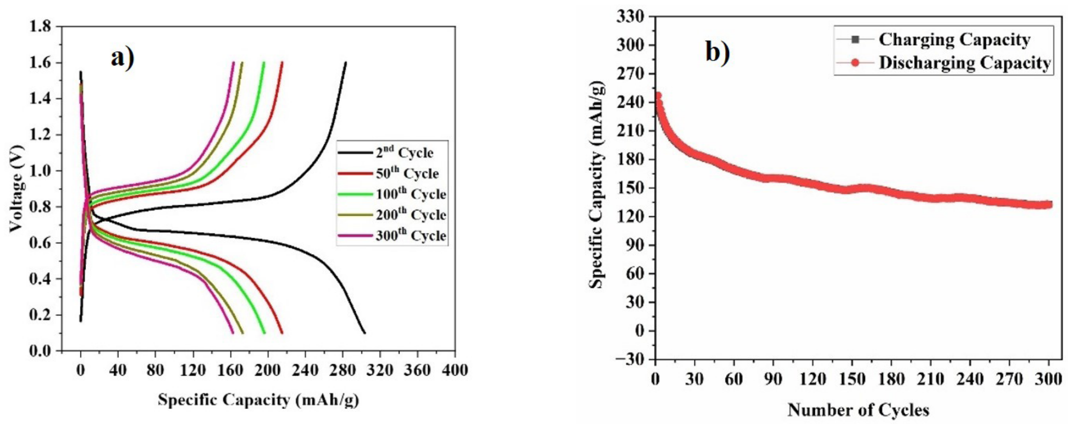


Fig. 1. Cyclic performance with charge-discharge plots of PNZ/Katjen black carbon Zinc coin cells with Nafion 212 membrane **a)** capacity vs. voltage plot **b)** cycle number vs. capacity plot.

Biography:

I am Priya. V, Ph.D. research scholar working under the guidance of Prof. S. Sankararaman and Prof. R. Kothandaraman, in the Department of Chemistry, Indian Institute of Technology Madras, Chennai, India since January 2019 till date. I am an enthusiastic research scholar, currently working in the area of Non-aqueous Organic Redox-Flow batteries and Organic metal-ion solid-state batteries.

Machine Learning Aided Capacitance Prediction for Hybrid Zinc-ion Capacitors and Employing Organic Redox Additives for Enhancing the Energy Density

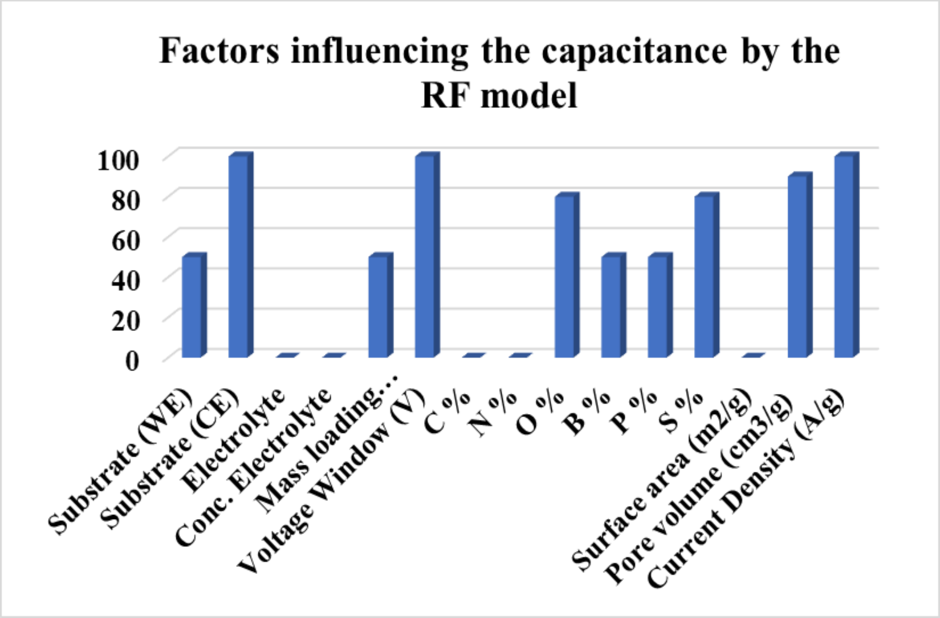
Sravani Potham*, Ganapathi Rao Kandregula, and Kothandaraman Ramanujam*

Indian Institute of Technology Madras, India

Abstract

Hybrid metal-ion supercapacitors are desirable energy storage technologies for electric vehicle and electric engineering because of their long cycle life, quick charge-discharge rate, and excellent power density. Biowaste-derived activated carbon is one of the strong contenders for high-capacity metal-ion supercapacitors among the numerous electrode materials utilized. Hence, developing an accurate and efficient technique for predicting electrochemical performance is crucial to reduce the time required for designing and testing electrode materials. Lately, machine learning has gained increased attention across the globe due to its superiority in prediction accuracy, cost-effectiveness, and time efficiency. In the current study, the experimental data have been collected from more than 100 research papers published from 2017 onwards and analyzed them by machine learning (ML) models to envisage the specific capacitance of carbon-based electrodes in zinc-ion supercapacitors (ZISCs). The input to the machine learning were physiochemical and various electrochemical properties. The physiochemical properties used in this work for predicting the specific capacitance of electrode material comprise carbon, oxygen, nitrogen, hydrogen, phosphorous, and sulfur atomic percentages, specific surface area, pore volume, the substrate for working electrode active

materials, and the counter electrode material as well as active mass loading of the electrode material. Electrolyte concentration and electrochemical properties such as potential window of the electrolyte, capacitance and the corresponding current density. Two different ML models were employed: random forest (RF) and multilayer perceptron neural network (MPNN). Prediction from RF model exhibited a root mean square error (RMSE) and correlation coefficient (R2) values of 77.92 and 0.88, respectively. The results revealed that the voltage window, substrates, current density, pore volume, and the atomic percentages of oxygen and sulfur played a significant role in predicting the specific capacitance accurately. But the energy density achieved by the ZISCs is comparatively lower than the batteries. To improve the energy density, we have devised an approach of modifying the electrolyte by adding organic redox additives. ZISC with activated carbon derived from chitosan flakes (Ch-C) as cathode, zinc foil as anode with 0.2 M hydroquinone (HQ) redox additive in 2 M $ZnSO_4$ as electrolyte was developed and its performance is predicted using ML. The fabricated device exhibited an outstanding energy output of 172 Wh kg^{-1} @ 0.5 A g^{-1} and a power output of 11 kW kg^{-1} @ 10 A g^{-1} due to the additional pseudocapacitive nature of the HQ. Furthermore, 100% coulombic efficiency and 85% capacitance retention are retained even after 15000 cycles at 5 A g^{-1} current density due to the complex chemical reactions between Zn^{2+} ions and HQ. For the first time in ZISCs, the ML approach have been theoretically introduced for predicting specific capacitance through a random forest algorithm with correlation coefficient (R2) values of 77.92, which is in good agreement with the experimental data. This work offers more understanding of the hybrid metal-ion supercapacitors that can serve as next-generation energy storage devices.



Biography:

Sravani Potham is a senior research scholar at the Indian Institute of Technology Madras, specializing in hybrid metal-ion supercapacitors. With a strong background in Chemistry, she is dedicated to advancing the field of electrochemistry. Sravani's passion for sustainable energy solutions drives her research, aiming to revolutionize energy storage technologies. Actively participating in conferences and symposiums, she eagerly explores new developments in electrochemistry. Outside of her work, she enjoys outdoor activities and indulging in scientific literature. Sravani's commitment, curiosity, and expertise position her as a promising researcher in the field, contributing to a sustainable and innovative future.

Combination of Nitro Isomers of Naphthoquinone on Delivering Improved Capacity and Cyclability to Zn-ion Batteries

Richa Gupta* and Kothanadaraman

Indian Institute of Technology Madras, India

Abstract

Aqueous Zn-ion batteries are considered as attractive and alternative energy storage devices to lithium-ion batteries because of their inherent safety, raw materials availability (10 million metric tons in India), and its favorable economics[1]. Research has been done so far on various cathode materials for aqueous ZIBs such as V_2O_5, MnO_2, and Prussian blue analogs; however, they have not demonstrated the required cycle life due to their deterioration[2]. Herein, we are focusing on non-toxic redox-active organic materials having quinone moiety i.e., 2,3-dichloro 1,4-naphthoquinone (1,4-DCNQ) and its derivatives 5-nitro 2,3-dichloro 1,4-naphthoquinone (5-DCNQ) and 6-nitro 2,3-dichloro 1,4-naphthoquinone (6-DCNQ) as cathode materials for aqueous Zn-ion batteries (ZIBs). Carbonyl groups (C=O) of quinone arethe active centers for their redox activity in energy storage devices[3]. In this study, we have demonstrated energy storage ability of 5-DCNQ, 6-DCNQ, and the effect of their mixture (DCNQmix). The constructed Zn/DCNQmix cell in 2 M zinc triflate electrolyte exhibited an initial capacity of 140 mAh g^{-1} at a current density of 0.1 A g^{-1}. In contrast, Zn/5-DCNQ and Zn/6-DCNQ cells show only 40 mAh g^{-1} and 55 mAh g^{-1} capacity, respectively. Zn/DCNQmix offers an extremely long life of 7500 cycles with a stable capacity of 70 mAh g^{-1} with a capacity decay of 0.0007 per day. The presence of Zn^{2+} in the discharged state and the absence of Zn^{2+} in the charged state are confirmed via ex-situ characterizations, which emphasize the electrochemical reversibility of the cell.

Keywords: Zinc-organic battery, quinone, crystalline, amorphous.

Biography:

I am Ms. Richa Gupta, a research scholar in the Department of Chemistry, Indian Institute of Technology Madras (IIT Madras), Chennai, India. I am working in organic materials based materials application in Zinc-ion batteries (ZIB) and Organic redox flow batteries (ORFB). I am designing and synthesizing the organic molecules for electrochemical studies. Hope this conference will improve and widen my knowledge in the energy area.

Energy Conversion and storage: Challenges from Materials' Science Perspectives

R. Neffati[1,2]*, Sohail Ahmad[2]

[1]Université Tunis El Manar, Tunisia, [2]King Khalid University, Kingdom of Saudi Arabia

Abstract

Energy generation is estimated to rise by 49% around 2040, due to the growth of world's population and the rising of living standards. During Glasgow (11-2021) meeting, a clear recommendation was issued to decrease the use of fossil energy sources which are non-renewable, and have dramatic impact on the environment. Hence, research about renewable energies are becoming the focus of materials scientist especially material for conversion and storage of energy (M-CSE). These materials are involved in different required systems in the next energetic transition such as: polymer proton exchange membranes (PEM), Lithium-ion batteries (LIBs), solar cells, water splitting photoelectrochemical cells, fuel cells and supercapacitors, etc....

In this talk the focus will be on these ECS materials by different approaches simulation as well as experimentally where one correlates the structural features to their properties in order to reach better performance for ultimate applications. The objective is to explore the different challenges in the development of ECS materials.

Biography:

R. Neffati, Ph.D (1999) in physics from the University of Paris XI after a M.Sc. in condensed matter Physics at ENS-Cachan, France. He lectured at University of Marne la vallée (Paris-est) during 1999-2000, then worked for three years as Post doc within the Dutch Polymer Institute at the Technical University of Eindhoven – the Netherlands. He holds a permanent position at the University of Carthage in Tunisia and works since 2015 at King Khalid University in Saudi Arabia. He authored more than 60 for different journals in the field of material sciences. He is interested in various topics in condensed matter and statistical physics.

Plasma-assisted Premixed Ammonia Flames: A Numerical Study

Mehdi Jangi

University of Birmingham, UK

Abstract

Ammonia as an alternative hydrogen fuel in the next generation of combustion devices is attractive because its well-established production, storage, and shipping industries associated with the fertiliser factories, hence, has great economic and environmental advantages over hydrogen or other hydrogen derivatives. Unfortunately, the combustion characteristics of ammonia are not compatible with the convention-based systems such as gas turbine andinternal combustion engines, which have been traditionally designed to operate with hydrocarbon-based fuels. The problem is that ammonia has a considerably lower reactivity as compared to fossil fuels and it can produce a high level of nitrogen oxides (NOx) emissions when it burns in conventional devices. It is known that macroscopic characteristics of fuel/oxidizer mixtures, such as ignition delays, flammability limits or laminar burning velocity, often impose constraints on efficiency and safety of practical combustion appliances. Therefore, the low reactivity nature of ammonia may result in unsafe and inefficient combustion in engines. In this light, enhancement and control of ammonia combustion processes are highly imperative to make this type of fuel applicable in various industries,especially if it can be achieved by modifying the mixture reactivity without changing the equivalence ratio or mass flow into a combustion device. To such aim, one-dimensional and three-dimensional numerical simulations are performed with different approaches, combined in a concept of plasma-assisted combustion, are presented, and the fundamental combustion characteristics of each approach are discussed. Pre-heating, plasma and mixing with hydrogen are compared and the stability and emissions behaviors of ammonia/air flames with each approach are quantified.

Biography:

Mehdi Jangi is an Associate Professor in Mechanical Engineering. His key research interests are application of computational modelling in decarbonising power and heat and sustainable materials, CFD modelling of complex fluid systems involving chemical reactions, turbulence, and multiphase phenomena, and has published over 70 papers in top ranked journals in this area. Following his PhD at Tohoku University, he moved to Sweden and undertook multiple research position at the Department of Energy Science at Lund University before joining Birmingham in 2018. In his career to date, he received several research grants from various sources including VR (Swedish Research Council), EU commissions and the UKRI.

Mounting Horizon of Green Energy Materials for Green Energy Storage Devices

R.B. Choudhary and S. Ansari

Indian Institute of Technology, IIT (ISM) Dhanbad, INDIA

Abstract

The surging concepts for immediate, effective and sustainable solution of energy crisis are spreading fast in due and duo resonance with inflated performance efficiency and zero emission protocol towards safe and healthy growth of the human society. These concepts stipulate the challenges for green energy production, storage, distributions and utilization system to be followed in academic, research, corporate and industrial sectors. Further, the relevance of green energy is more applicable in green material solutions to energy problem. Since green energyis a multidisciplinary, rapid-research forum for the science and engineering of green materials and green devices used in all forms of energy production, harvesting, conversion, storage, utilization and relevant policy. This requires ever advancement in the energy device fabrication with utmost material design-feature and precise precursors involved therein. Varying categories of precursors based upon eco-friendly fillers, polymer derived green hybrids, and organic bio-waste products are being exercised. These feedstocks potentially yields with numerous admissible advantages in the design-development of green energy storage devices thereby diminishing undesirable and excessive volume of the bio-wastes in the environment. These are primarily featured with numerous recommendatory characteristics including high porosities, relatively low costs, better ease of synthesis and immeasurable accessibility. Although, these green candidates markedly suffer from many more supercapacitive shortcomings such as low energy density, inferior cyclic stability and poor specific capacitance. However, these limitations can be taken over and resolved thereby employing innovative techniques such as tuning of surface morphology, befitting doping action, and accelerated synergistic features. In this discussion, authors aim to emphasize on the viable approaches with scientific inputs, mega mechanism of actions and ensuing advantages of the material features for green energy storage system delineated for evergreen and efficacious energystorage devices with the least environmental repercussions and reverberations comprising of 2-dimentional and 3- dimentional hierarchical porous activated carbons from agricultural and bio-waste products and their fibrous contents with ameliorated electrochemical performance.

Forum on "Que Vadis Domine – on Future Retrofitting Residential Buildings"

Mark Bomberg, Clarkson University, Potsdam, NY, USA

Abstract

A unified approach for the next generation of new and retrofitted residential buildings is based on four decades experience of passive housing in North America and almost three in the EU. Before the SAR coV 2 pandemic, Europe and America differed in their main approaches to indoor air handling in residential buildings. The pandemic, however, revealed shortcomings in both approaches and a need for improvement. The authors propose a merger of these approaches. Obviously, some details will be tailored to accommodate the climate differences but the success with regard to covid infection in interior spaces must be as good as that for outdoor spaces.

The authors analyze heating, cooling and ventilation aspects of housing and propose a unified technology called a generic name Environmental Quality Management (EQM). New elements in this technology are:

1) Introduction of a two-stage construction process for both new and retrofit cases, that modifies patterns of financing. In the first stage, the best possible performance within a prescribed investment limit is the objective; in the second stage, reduction of the cost of the required energy efficiency level is the objective.

2) A building automatics controls utilization of thermal mass that also includes a geothermal storage linked with solar panels trough hydronic system and heat pump. One implements the concept of adaptable indoor climate as well as a full integration of HVAC with the building structure. This is accomplished with assistance of a monitoring and performance evaluation (MAPE) system. Introducing automatics to the design process offers improved integration of building subsystems and introducing energy optimization in the post-construction stage.

3) A subset of this technology is Environmental Thermo-Active (ETA) technology developed specifically for retrofitting projects

The ETA is a result of improvements already applied in practice to reinforce the role of a triangle: occupant-controlled comfort, energy efficiency and interaction of buildings with smart energy grid as the driving force of progress.

Keywords: energy efficiency; building automatic control; field energy use; two-stage construction process; cost-benefit evaluation; affordable retrofit of residential buildings

Plenary Presentation

No Miracles Needed: Transitioning the World to 100% Clean, Renewable Energy and Storage for Everything

Mark Z. Jacobson

Stanford University, Stanford, CA, USA

Mark Z. Jacobson's career has focused on better understanding air pollution and global warming problems and developing large-scale clean, renewable energy solutions to them. Toward that end, he has developed and applied three-dimensional (3-D) atmosphere-biosphere-ocean computer models and solvers to simulate and understand air pollution, weather, climate, and renewable energy systems. He has also developed roadmaps to transition countries, states, cities, and towns to 100% clean, renewable energy for all purposes and computer models to examine grid stability in the presence of 100% renewable energy. Jacobson has been a professor at Stanford University since 1994. His research crosses two fields: Energy and Atmospheric Sciences

Oral Presentation

Techno-Economic Wood Procurement Model from Renewable Forests for Profitable Energy Production in CHP Plant

Teijo Palander

University of Eastern Finland, Finland

Abstract:

The aim of this study was to find out the CHP plant's ability to pay for wood with different wood fuel procurement chains and to determine the company's wood procurement area for the renewable forest. For the formulation of the model, the income received from the sale of energy and the costs incurred from the procurement were collected as data. After the model was formulated, different procurement chains for whole tree (trunk, branches and top) and trunk wood were compared in terms of the company's ability to pay for wood.

From the results, it can be concluded that it is possible to profitably purchase whole wood from forest clear-cutting sites that located near the energy production plant through ordinary wood trade (the buyer does wood harvesting and transport to the factory), but it is nonprofitable at partial logging sites, where only small trees are harvested from the forest, while large trees continue growing. With a more comprehensive procurement transaction (the seller harvests the wood to the roadside), the purchase of both whole wood and trunk wood would be possible at the used price level in terms of ability to pay. The seller can also deliver the wood to the terminal of the energy company by using a factory delivery deal. However, based on regional forest data the supply of wood fuel cannot be successful by using the whole tree procurement when the procurement area is created from renewable forests. Furthermore, starting a large-scale roadside purchase of whole tree would also increase competition due to the limited supply and thereby increase prices. Fortunately, there is sufficient energy stock available in the nearby areas also for trunk wood procurement.

With the cost structure used in the study, buying wood through procurement by roadside and factory delivery trade is more profitable than through ordinal trade. Due to the mentioned factors, wood procurement should, at least in the initial phase, mainly focus on roadside and factory supply procurement of the energy wood chain, if the price ratios of energy sales do not change significantly. The techno-economic timber payment ability model developed in the study proved to be a useful aid when updating information and instructions for timber buyers in the field. It is an easy-to-use Excel-based tool with the new important so-called procurement area module which considers renewable forests based on the regional tree stand data.

Biography:

Teijo Palander works as the full professor of Forest Technology in the Department of Science of Forestry.

Producing a Novel Biodiesel from Waste Doner Kebab Fat and Assessing its Fuel Properties Under Different Production Conditions

Batuhan Erden[1]*, Haider Tasawar Kiani[1] and Kemal Masera[1,2]

[1]Middle East Technical University, Turkey.

[2]College of Engineering and Physical Sciences, United Kingdom.

Abstract

Biodiesel has been appointed as a promising alternative to fossil diesel in the literature because of its advantages, compatibility with diesel engines, and being carbon neutral. However, most of the industry mainly relies on waste cooking oil as a feedstock, which is also limited. Biodiesel can also be produced from animal fats and algal oils. Doner kebab fat is also a promising feedstock alternative as it has minimum contamination and easy storage/transportation. However, its highly saturated content is a challenge to meet European biodiesel quality. Therefore, the aim of this study is to assess the thermophysical quality of a novel biodiesel produced by waste doner Kebab oil and check its quality against the EU 14214 standard. Doner is a traditional food in middle eastern countries, and it is highly available as a waste. The waste doner fat collected from a local shop is converted to biodiesel through transesterification technique at 55℃ and 60℃ with and without a condenser are analysed. Density, viscosity, and calorific values are experimentally measured, also cetane value, iodine value, and freezing point are estimated based on beef tallow fatty acid methyl ester (FAME) composition obtained from the literature. According to the results, yields were 92% and 95% for the transesterification at 55℃ and 60℃. The visco calorific v the biodiesel produced at 55 ℃ without washing were measured as 4.165 mm^2/s and 42.5 MJ/kg which are promising compared to other animal fat derived biodiesels in the literature. In addition, there were no freezing observed in the sample at the laboratory conditions.

Biography:

Batuhan Erden is an undergraduate mechanical engineering student at Middle East Technical University, Northern Cyprus Campus. He is conducting research in the biofuels and renewable energy field under the supervision of Dr Kemal Masera.

Integrated Algal-Oil Palm Biorefinery for Sustainable Energy and Bioproducts Co-generation

Mohd Azmuddin Abdullah

SIBCo Medical and Pharmaceuticals Sdn., Malaysia.

Abstract

Carbon dioxide and methane emissions, and plastic pollution with debris in the oceans and ecosystems, are global major problems - yesterday, today and tomorrow. These have contributed immensely towards environmental disasters and unpredictable weather patterns, which further exacerbate the existing wide gap between the haves and the have-nots, especially in the developing world. The solutions to tackle the challenges must involve broad-based, multi-pronged and multi-dimensional strategies, cutting across parochial lens. There is an urgent need to make the action plan to address the 17 agenda of global SDGs, to be alive and kicking, hitting the ground and running in full speed, beyond the confines of meeting rooms, air-conditioned halls and lecture theatres. In this presentation, the development of Integrated Algal-Oil palm Biorefinery for sustainable energy production with environmental remediation and bio/eco-friendly products co-generation will be highlighted. These will be co-ordinated with the need to address sustainable energy, food, water, climate and social security. An action-oriented framework in the form of HEESBA Consortium will be outlined. **HEESBA**, from Arabic word "Hisbah" for "Accountability", is the acronym for "**H**ealth consciousness; **E**nvironmental and Safety awareness; **E**nergy sufficiency; **S**ocial inclusiveness; **B**usiness acumen; **A**daptability and Agility". The philosophy of the Enterprise is to strive for Profitability with Social inclusiveness, and Wisdom to execute. The efforts to polish the 4 diamonds of **H◆E E◆S◆B◆A** - Bioenergy, Biomaterials, Biochemicals and Education, will be elaborated. The consortium takes cognizance of economic development with social impact and wisdom intact, whilst reaping the Profit for the People and the Planet.

Biography:

Mohd Azmuddin Abdullah obtained an M. Eng in Chemical Engineering and Biotechnology (1994) from the University of Manchester Institute of Science and Technology (UMIST), United Kingdom, and a PhD in Bioprocess Engineering (1999) from Universiti Putra Malaysia (UPM). He was a Visiting Scientist (1997)in Kinki University, Japan, and a Post-Doctoral Fellow (2000-2001) at the Biomaterials Science and Engineering Laboratory, Massachusetts Institute of Technology (MIT), USA. He was an Academic in UPM (1994-2004), Universiti Teknologi PETRONAS (2004-2014), and Universiti Malaysia Terengganu (2015- 2021). He was appointed as the Director of R&D in SIBCo Medical and Pharmaceuticals Sdn. Bhd. since August 2021.

Visualization Inside Fuel Cell and Lithium-ion Battery under Operation Modes

S. Hirai[1]*, S. Uemura[2]

[1]Tokyo Institute of Technology, Japan

[2]Hokkaido University, Japan

Abstract

Proton exchange membrane fuel cells (PEFC) and lithium-ion secondary battery (LIB) are regarded as promising alternative clean power sources for automobile applications and storage of renewable energy. PEFC and LIB needs higher performance, i.e., high current density to achieve cost reduction and downsizing for PEFC and higher specific capacity and rapid charge/discharge for LIB. In order to improve the performance, fundamental mechanism of the mass transport phenomena in PEFC and LIB under in-situ conditions need to be elucidated. We have developed a soft X-ray microscopy system, which is an advanced imaging system that could visualize water and Li ion in PEFC and LIB, respectively. It could be used in ordinary laboratories without synchrotron and neutron sources. Current density corresponds to liquid water production in fuel cell. It is noted that although H2O is produced at the catalyst layer, liquid water firstly appears near the cathode rib. The concentration distributions of lithium ions inside the hard carbon negative electrode were able to be investigated. Diffusion of lithium ion is restricted by high lithium-ion concentration at a rapid discharged mode. These results suggest that transport phenomena in PEFC and LIB could be evaluated quantitatively by the advanced soft X-ray microscopy technique.

Biography:

Since 1993, he has been with Tokyo Tech. From 1993, his research centered on CO2 ocean sequestration and extended to CO2 underground sequestration since 1997. From 2008, he has made a success on measurement of water inside gas diffusion layer of fuel cell using special technique of X ray. This technique is also applied to measure lithium-ion profile inside lithium- ion battery. Although his knowledge is based on mechanical engineering area, it is widely used to energy and environmental issues.

Assisted and Unassisted Starter Techniques for the Subfreezing Operation of the PEM Fuel Cells

Alparslan Topcu[1]*, Merve Topcu[2], Kadir Aydın[3], Selahattin Çelik[4]

[1]Alanya Alaaddin Keykubat University, Turkey; [2]Harran University, Turkey; [3]Çukurova University, Turkey; [4]Ankara Yıldırım Beyazıt University, Turkey

Abstract

PEM fuel cell-powered vehicles (FCVs) become widespread year by year, and many automakers have released their FCV models to the market. Toyota introduced the first mass-production FCV model 'Mirai' in 2015. Besides, hydrogen fuel cell-powered unmanned aerial vehicles (UAVs) offer fast charging and long flight time advantages over the battery systems in aviation applications. However, some chronic problems of the PEM system should be improved, and cold start phenomena is one of the most important challenges of the PEM fuel cell systems. Some assisted or unassisted research techniques are applied in the literature to enhance the cold start ability of the PEMFC system.

In this paper, coolant assisted heating method which provide huge instant power and homogeneous temperature distribution along the heating area was adopted to enhance the cold start ability of the PEM fuel cell. A series of experimental studies were conducted using single-cell stack and short stack was operated with the external heating mechanism synchoronously. Temperatures of the cathode bipolar plate was followed by symmetrically placed five thermocouples. Temperature values were obtained and presented with voltage-current graphs. The characteristics of the cold start strategies were discussed under the same energy consuming level and the effectiveness of the operation durations of the heating mechanism components were revealed.

Biography:

Alparslan Topcu received his Ph.D. degree in 2023 from the Automotive Engineering Department of Çukurova University in Turkey. His research interests are PEM fuel cells and especially cold start applications including assisted start-up techniques and instant heating approaches. Besides, he studied solid oxide fuel cells (SOFCs) and the manufacturing of interconnects by powder metallurgy (P/M) approach and glass-ceramic sealant fabrication. He has publications on additive manufacturing and composite materials as well as fuel cell articles. He is working as an instructor in the Mechanical Engineering Department of Alanya Alaaddin Keykubat University (Turkey) currently.

Green Hydrogen Production and Exploitation: Why enzymes do it Better

Francesca VALETTI, University of Torino, Italy

Abstract not avaialble

Techno-Economic Calculator for Hydrogen Transport and Storage: An Assessment tool to Support Early-stage Commercialization

Ida Synnøve Bukkholm*, Md Rizwan and Erik Andreas Hektor

Low Carbon Technology program, Research and Development, DNV, Norway

Abstract

Hydrogen is expected to play a prominent role in the energy transition to low carbon future [1]. However, a major challenge in the initial phase of projects in the hydrogen value chain is the estimation of the economic cost and emissions associated with different transport and storage options available in the market. To address this challenge, we developed an assessment tool to quantitatively compare these options and help project developers during early-stage decisions in commercial projects.

The developed assessment tool provides functionalities to obtain techno-economic data for

comparing options to transport (via pipelines or trucks/ ships), store (in salt caverns, storage tanks), and convert hydrogen between phases (liquid/gas) depending on the producer and consumer's requirements. The transport of hydrogen through a pipeline uses the general flow equation to calculate pressure drop and power requirements to **compress and deliver** hydrogen at desired requirements [2]. Storage of hydrogen in salt caverns can be seasonal, weekly, or daily, and costs for the surface and subsurface work involved depends on the duration of storage and the depth of the cavern [3]. The tool can calculate costs of storing hydrogen as a compressed gas, or liquid gas for a shorter duration. However, the conversion from gaseous to liquid hydrogen requires significant amounts of energy and hence, increases the cost [4].

The examples included in this work compare different modes of transport and analyze important trends associated with hydrogen storage and transportation. Hence, this tool provides the framework to compare the levelized cost of hydrogen transport and storage, OPEX, and CAPEX corresponding to options for hydrogen transport and storage.

Poster Presentation

Green Storage for Green Hydrogen: The Gas Hydrate Platform

Sahar Jafari Daghalian Sofla, Phillip Servio and Alejandro D. Rey

McGill University, Canada

Abstract

Climate change is a global environmental concern for our generation. Many countries including Canada are committed to international and domestic climate change agreements. They have set an ambitious goal of achieving zero emissions by 2050 in order to limit global warming to 1.5 degrees Celsius. Achieving this goal requires a significant transformation in the energy sector. This research aims to contribute to these efforts by developing a sustainable storage system for hydrogen. Hydrate technology offers a promising solution for storing hydrogen. Hydrates are solid structures formed by water molecules and guest gas molecules, creating cage-like crystalline structures under relatively high pressures and low temperatures. The experimental exploration of hydrates is complicated by the energy-intensive experiments and by the difficulty of controlling sample purity and homogeneity at extreme formation. To overcome these challenges, this research project uses Density Functional Theory (DFT) to determine the hydrogen storage capacity of hydrates and investigate the effects of pressure and cage occupancy on the system's energy, structure, and stability. The accuracy of the results is validated through comparisons with experimental and computational data. The study reveals that DFT yields occupancy limits beyond previous reports and demonstrates storage capacities comparable to those set by the Department of Energy. The storage capacity is influenced by various factors, including host-guest dispersion interactions, hydrogen bonding, and cage type. The occupancy limit and the mechanism behind the limits are stablished which will will be crucial in deploying hydrates for long-term hydrogen storage.

Biography

Sahar Jafari Daghalian Sofla is a PhD candidate in the Hydrate Tech and Material Modelling Research Group at McGill University, Canada. Her current research focuses on the development of environmentally friendly storage solutions for hydrogen, with a specific emphasis on the Gas Hydrate Platform. Prior to her enrollment at McGill University, she completed her undergraduate studies at the University of Tehran, Iran. Her academic journey has been marked by outstanding achievements, including being awarded the University of Tehran Excellence Award and the McGill

Engineering Doctoral Award (MEDA). Sahar's research interests comprise of energy storage systems, material modelling, and numerical simulations in the field of Chemical Engineering.

Low-cost Functionalized Graphene Nano Fiber/Nafion Composite Cation Exchange Membrane for Vanadium Redox Flow Battery application

Harun Khan[1], Aiswarya Kesh[2], R. Kothandaraman[1*] and AK Sahu[2*]

[1]Indian Institute of Technology Madras, Chennai, India

[2]CSIR - Central Electrochemical Research Institute, Tamil Nadu, India

Abstract

Over the past few years, Nafion is the most widely used membrane due to its good proton conductivity and excellent chemical and mechanical stability. But it has poor barrier properties toward vanadium ions due to its well-developed water channels. Herein, to reduce vanadium ions permeability across the membranes without compromising the proton conductivity, graphene nanofiber (Herringbone type, GNF-H) as a filler has been incorporated to the Nafion matrix to fabricate the composite membrane. The membranes have been prepared by solution casting method and subjected for physiochemical characterization, vanadium ion permeability, self-discharge test, electrochemical impedance spectroscopy and galvanostatic charge discharge at different current densities. In the case of 0.75% and 1 % GNF-H composite membrane, vanadium permeability has been reduced significantly. The composite membranes having 0.5%, 0.75%, and 1 % GNF-H showed the capacity of ~ 18.2, 18.9 and 16.8 Ah L^{-1} at 100 mA cm^{-2} respectively. These values are comparatively higher than that of the Nafion™ 117 which exhibits a capacity ~16.3 Ah L^{-1} at same current density. The polarization study reveals that the peak power of the cells consisted of 0.5%, 0.75%, 1% GNF-H composite membrane and Nafion 117 is ~ 538, ~ 507, ~ 465 and 388 mW cm^{-2} respectively. The present study concludes that the application of Nafion/GNF-H in the VRFB system can be a promising strategy to reduce the vanadium ion permeation, cost cutting and successfully improve the VRFB performance.

Biography:

I am Mr. Harun Khan, a research scholar in the Department of Chemistry, Indian Institute of Technology Madras, Chennai, India. I am working on design and development of new materials for flow batteries such as Vanadium redox flow batteries and soluble lead acid redox flow batteries for sustainable large scale energy storage.

Challenges and coping strategies for decarbonization in coal regions in Europe. Silesia as a case study of Poland

PEPŁOWSKA Monika[1*], KRYZIA Dominik[2], KOMOROWSKA Aleksandra[3], KOWALIK Wojciech[4], HUBERT Wit[5], GAWLIK Lidia[6]

[1,2,3,4,6] Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland; [5]AGH University of Science and Technology, Poland;

Abstract

The project ENergy TRANsitions from Coal and carbon: Effects on Societies ENTRANCES is a three-year initiative supported by the European Union's Horizon 2020 research and innovation program. The project's primary objective is to cultivate a comprehensive and well-supported comprehension

ABSTRACT BOOK

of various interrelated topics within the realm of social sciences and humanities (SSH) in the context of the 'Clean Energy Transition' in European coal mining and carbon-intensive regions. These encompass socio-economic, socio-technical, socio-ecological, socio-cultural, socio-political, socio-psychological, and gender-related aspects. The ultimate goal of this endeavor is to generate a set of recommendations aimed at addressing the challenges faced by these regions, while considering a multitude of perspectives involving key stakeholders at local, regional, national, European, and global levels. As a coal region in ENTRANCES we analyzed seven coal region: Silesia (Poland); Lusatia, Rhineland and Central Germany (Germany); Jiu Valley (Romania); Sulcis Iglesiente (Italy); Upper Nitra (Slovakia). The article presents challenges and coping strategies for decarbonization in coal regions in Europe. Specifically pointing out the case of Silesia which is Poland's main hard coal mining region and the largest hard coal mining area in the European Union. Currently 19 out of 20 coal mines operating in Poland are located in this coal territory, which account for approximately 85% of the domestic hard coal production, including 100% coking coal.

Experimental Study of Heat and Mass Transfer during Thermal Runaway of a Li-ion cell

Charbel Nouhra[1,2,3*], Alain Bengaouer[1], Stéphanie De Persis[2,3], Nabiha Chaumeix[3], Jérôme Cognard[1], Kamel Bachir Elezaar[1], Paul Maire[4], Daniel Marteau[4], Sébastien Dubourg[4]

[1]Université Grenoble Alpes, France

[2]Université d'Orléans, France

[3]ICARE, France

[4]CEA, France

Abstract

Li-ion batteries offer multiple advantages, including high energy and power density, high efficiency and long lifetime. As a result, they are being widely used in variety of fields, such as electric transportation, portable devices, and energy storage stations that stabilize renewable energy production. However, despite these advantages, one issue of Li-ion batteries is their safety, as in some cases, internal exothermic reactions between the anode, the cathode and the electrolyte can lead to a thermal runaway. Thermal runaway causes a sudden energy release, flammable gases and particles release, and eventually explosion of the cell. Ultimately, the thermal runaway could propagate to surrounding cells in the battery module or pack. Therefore, the safety of batteries is an essential concern for users and manufactures. This study focuses on the cell level, and we have defined our study parameters to identify and quantify the energy and mass released during thermal runaway of a Li-ion cell. Our literature review shows that many studies investigated energy and mass released during thermal runaway with different test devices and several operating conditions. Nonetheless, determining the potential risks remains complex due to the diversity of data. Importantly, until now, no scientific paper that takes into account the same cell type tested using different devices has been published, so the impact of the test device remains unclear. The poster will describe a new methodology for comparing experimental results obtained from different devices utiliz me cell. Our work focuses sed-system devices: a small-scale tube calorimeter ($V \approx 0.5L$) and a large-scale vessel ($V \approx 250\ L$). For both devices, temperatures, gas volume, particles mass and energy releases obtained in different environmental conditions will be compared to understand the impact of the device on the thermal runaway of a Li-ion cell.

Biography:

Charbel NOUHRA, from Lebanon, obtained a bachelor's degree in mechanical engineering from the Lebanese University and a Master 2 in fluid dynamics from INSA Toulouse in 2022. I then started

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my PhD in November 2022, at CEA LITEN France, in collaboration with ICARE CNRS France. My research focuses on the experimental study of heat and mass transfer during thermal runaway of a Li-ion cell.

Bio-hydrogen from Municipal Wastes: Preliminary Results of MoDSEn Project

Graziano Tassinato*,[1], Pietrogiovanni Cerchier[2], Margherita Turatello[1], Marco Biasiolo[3], Francesca Mazzolini[3], Cristina Cavinato[3]

[1]Green Propulsion Laboratory, Italia

[2]9-tech srl, Italy

[3]Ca' Foscari University of Venice, Italy

Abstract

Hydrogen production via biological routes, as dark fermentation of organic biomass, is a suitable alternative and renewable energy source especially if waste such as agricultural residues, agro-industrial waste, and organic municipal waste, are used. The aim of the MoDSEn project is the construction of a pilot plant for biohydrogen production from food waste and waste activated sludge, considering the whole process, from waste pre-treatment to hydrogen separation systems and electric energy production. The dark-fermentation semi-continuous process was performed using a waste/sludge ratio of 1:1 in VS and digestate as inoculum. Preliminary results indicate that the optimal organic loading rate is between 10 and 15 kgVSfeed/m^3reactor, with a hydraulic retention time of 3 days and with pH control between 5.2 and 5.5. The specific gas production at steady state condition was 120 NL/kgVS with about 30% of hydrogen content. To take full advantage of the proposed process it is important to have a holistic view of the whole approach, considering also the advantage of bio-based solution such as purple non sulphur bacteria (*Rhodopseudomonas palustris*) to improve hydrogen yields through the use of organic acid production in dark fermentation.

Biography:

Graziano Tassinato PhD, Master degree in Microbial Biotechnologies at Florence University, Ph.D in Environmental Science, post Doc specialization in Environmental Chemistry. Since 2017 R&D Manager of Green Propulsion Laboratory of Veritas Group. Since 2007 R&D Manager for VEGA- Scientific and Technological Park of Venice. His experience is focused on biotechnology development (from lab to demo scale) and deployment in the areas of upstream, refining and chemical technologies.

Photoelectrocatalytic Study of N-Doped $SrTiO_3$

Krateeka Madan* and G. Ranga Rao

Indian Institute of Technology, Madras

Abstract

$SrTiO_3$ is the most studied photoactive titanate due to its excellent photostability and corrosion resistance in aqueous solutions. However, like other metal oxides due to wide band gap its photocatalytic activity is limited to 4-6% of the solar spectrum [1]. Structural modifications such as doping, introducing defects etc. are required for band gap alteration to increase the absorption range. Nitrogen doping has drawn a lot of interest due to its effective photo-absorption of visible

light. Furthermore, chemical, electrical, and structural features such as electronegativity (N=3.04, O=3.4), ionic radii (N=1.46Å, O=1.4Å) and coordination number are similar between oxygen and nitrogen. As a result, nitrogen can substitute for oxygen at the same lattice location in the crystal structure while maintaining structural compatibility with the comparable oxide [2,3]. $SrTiO_3$ was synthesized using hydrothermal method with $Sr(NO_3)_2$ and TTIP (titanium tetra isopropoxide) as the strontium and titanium precursors. For the synthesis of N-doped $SrTiO_3$, 500mg of the prepared $SrTiO_3$ was kept in ammonia flow at 1000℃ for 15 hours, 30 hours and 45 hours respectively. With the incorporation of N into the $SrTiO_3$ lattice the band gap decreased from 3.2 eV for STO to 2.8 eV for STON. The values for the onset potential are STO (-0.252V), STON-15 (-0.201 V), STON-30 (-0.274 V), and STON-45 (-0.297 V). There is an increase in the number of absorbed photons which is reflected in decrease of the onset potential which is lowest for the STON-15 sample. The samples are characterized using XRD, SEM, Raman, UV and EPR.

Challenges and coping strategies for decarbonisation in carbon-intensive European regions. The Kraków Metropolitan Area as a case study of Poland

KRYZIA Dominik[1*], PEPŁOWSKA Monika[1], KOMOROWSKA Aleksandra[1], KOWALIK Wojciech[2], HUBERT Wit[1], GAWLIK Lidia[1]

[1]Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland; [2]AGH University of Science and Technology, Poland;

Abstract

The project ENergy TRANsitions from Coal and carbon: Effects on Societies ENTRANCES is a three-year initiative supported by the European Union's Horizon 2020 research and innovation program. The project's primary objective is to cultivate a comprehensive and well-supported comprehension of various interrelated topics within the realm of social sciences and humanities in the context of the 'Clean Energy Transition' in European coal mining and carbon-intensive regions. These encompass socio-economic, socio-technical, socio-ecological, socio-cultural, socio-political, socio-psychological, and gender-related aspects. The ultimate goal of this endeavor is to generate a set of recommendations aimed at addressing the challenges faced by these regions, while considering a multitude of perspectives involving key stakeholders at local, regional, national, European, and global levels.

In ENTRANCES we analyzed one of 6 carbon-intensive regions: the Krakow Metropolitan Area (KMA). Within the project, the KMA has been identified as an area where intensive use of solid fuels contributes significantly to high levels of air pollution, impacting the quality of life in the region. The problem of low emissions, stemming from the widespread use of classless coal-fired boilers, is further complicated by challenges related to territorial development and economic transformation. In communes belonging to the KMA, more than 50% of households still use hard coal to heat their houses.

A Study on the Optimal Control Strategies of Hydrogen City in South Korea

MinSu Kim*, TaeYoung Jyung

Korea Electric Power Engineering & Construction (KEPCO E&C), South Korea

Abstract

Currently, inverter-based power supply is increasing as the proportion of renewable energy in the power system increases. As a result, the inertia of power generation resources is reduced,

threatening the stability of the power system, and sometimes even curtailments occur, making efficient use of energy difficult. In this situation, sector coupling that integrates different energy sectors around the world to improve energy use efficiency, and in particular, a lot of research is being conducted on power generation-hydrogen-linked sector coupling that converts surplus power of renewable energy into hydrogen energy. In South Korea, the construction of hydrogen cities is underway to explore the potential of sector coupling and seek solutions for power grid issues. In this study, we introduced hydrogen city under construction in South Korea and optimal control strategies from the perspective of Energy Management Systems for both grid-connected and standalone operation modes, based on the city's composition and capacity, and evaluated the control strategies in terms of curtailments, grid stability and economic feasibility. For this study, deep learning and machine learning techniques were used for forecasting renewable energy generation and load consumption, and linear mathematical optimization were used for optimal scheduling. Through research on such community-level sector coupling, we confirm its effectiveness in addressing renewable energy variability and ensuring grid stability and flexibility. This information can be used as a reference for future applications of renewable energy-hydrogen energy-based sector coupling, not only at the community level but also for long-term Energy Storage System deployment across the entire power grid.

Biography:

MinSu Kim is a Junior Researcher of KEPCO E&C and currently master's degree in Kyungpook National University. His research focuses specifically on data science and energy big data, and he is studying machine learning, deep learning, and operation research.

Clean Energy & Material Sciences

Energy Storage: The Missing Piece in the Puzzle of Sustainable Energy

Pedro GOMEZ-ROMERO, Catalan Institute of Nanoscience and Nanotechnology, Spain

Pedro GOMEZ-ROMERO (FRSC) is Full Professor of the National Research Council (CSIC, Spain) and Group Leader of the NEO-Energy Lab at ICN2, Barcelona, Spain. Leading projects on materials and devices for energy storage and conversion, with emphasis on batteries, supercapacitors and hybrid devices, pioneering the use of polyoxometalates as energy storing materials. Fellow of the Royal Society of Chemistry since 2014, CIDETEC Award to research on electrochemistry in 2017. Cofounder of the spin-off Napptilus Battery Labs. Author of four award-wining popular science books, as well as two technical books (Functional Hybrid Materials, Wiley-VCH, 2004) (Metal Oxides in Supercapacitors, Elsevier, 2017).

Rational Design of Advanced Heterostructures for Solar Energy Conversion

Anita Trenczek-Zajac*, Joanna Banas-Gac, Anna Kusior, Małgorzata Knapik and Marta Radecka

AGH University of Science and Technology, Poland

Abstract

Various research fields encompass environmentally conscious light-triggered processes using heterogeneous photocatalysis. These fields are dedicated to addressing and mitigating negative events. One strategy involves harnessing renewable energy resources, primarily through the breakdown of water, where solar energy transforms into chemical hydrogen energy. This particular application demands that photoactive semiconductors interact directly with both the reaction medium and light. There exist multiple semiconductors capable of acting as photocatalysts within the water splitting process. These semiconductors need to adhere to specific criteria: suitable band structure, minimal recombination rate, efficient charge carrier mobility with extended diffusion pathways, resistance against photo(electro)corrosion, and economical viability. Given these conditions, the options become constrained and predominantlyencompass a subset of broadband semiconductors. Nevertheless, achieving an extended range of light absorption while retaining their inherent benefits requires adjustments to the electron structure. Thus, the transition from a microscale approach to a nanoscale approach seems promising, involving the creation of a heterostructure comprising two semiconductors with differing band structures.

The objective of the investigation was to fabricate semiconductor heterostructures such as TiO2@ MoS2, TiO2@Cu2O, TiO2@BiVO4, and TiO2@CdS, each of which has a deliberately engineered architecture. These structures were intended to facilitate effective hydrogen generation in the context of photoelectrochemical water splitting.

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A Study on the Kinetic Characteristics of Nanoscale Ceramic Powder Synthesis by Microwave-Assisted Heat Treatment

Nam-Hee Cho*[1], Han-Sol Yun[2], and Jin-Won Bak[3]

[1]Inha University, South Korea; [2]Samsung Electro-Mechanics, South Korea; [3]Hanyang University, South Korea

Abstract

The kinetic effect of microwave-irradiation on the synthesis of nanoscale ceramic powders from hydrate precursors was investigated. The structural and chemical features of powders synthesized via microwave-assisted heating (MWH) and conventional heating (CH) were compared. The charged radicals were generated by the interaction between the precursors and the injected microwaves, resulting in highly energetic states. These charged radicals were identified by chemical analysis and real-time charge flux measurements.

In case of $BaTiO_3$, using $Ba(OH)_2{\cdot}H_2O$ (BH1), $Ba(OH)_2$ (BH0), and $BaCO_3$ (BC) as the precursors for Ba source, and $TiO_2{\cdot}4H_2O$ (TH) for Ti source, three different mixture samples: BH1TH (BH1+TH), BH0TH (BH0+TH), and BCTH (BC+TH) were heat-treated in the temperature range of 100–900 °C. Based on the growth exponent (n), the synthesis reactions were inferred to be diffusion-controlled processes ($3 \le n \le 4$) for MWH and interface-controlled processes ($2 \le n \le 3$) for CH. Current densities of approximately 0.073 and 0.022 mA/m^2 were measured for samples BH1TH and BH0TH, respectively, indicating the generation of charged radicals by the interaction between the precursors and injected microwaves.

The radicals were determined by X-ray photoelectron spectroscopy and Fourier transform infrared spectroscopy. The crystallization activation energy for BH1TH via MWH was estimated and compared with that measured for BH1TH via conventional heating (CH); $BaTiO_3$ powders were synthesized at temperatures as low as 100 °C. The details of the kinetic effects of microwave-irradiation on the synthesis of nanoscale oxide powders will be presented in the conference.

Can Supercapacitors Change the Roadmap of Power Electronics for Renewable Energy Systems.

Nihal Kularatna

The University of Waikato, New Zealand

Abstract

Supercapacitors are one million times larger capacitance for the same canister size of common electrolytic or film capacitors. Commercially available energy storge devices come with capacitance values from fractional farads to 100,000 F per cell, with DC voltage ratings from 2 to 4 V in general. These devices have life cycles in the range of 30,000 to 1,000,000, compared rechargeable battery chemistries with cycle life from 1000 to 2500. Hence, they are fit-and-forget devices in power electronic building blocks in renewable energy systems.

Commercial versions of these devices also have several orders larger power densities, compared to rechargeable batteries. Only weakness of these is the smaller energy density compared to rechargeable battery technologies. With hybrid devices entering the commercial domain, this weakness of supercapacitors is diminishing gradually.

The paper presents an industrial summary of commercial supercapacitor families and some unique applications, followed by a new design approach for power electronic building blocks for power converters and protection systems. Paper will also compare traditional power converter design approaches based on high frequency switch mode techniques with the low frequency design approach of the new design approach now known as Supercapacitor Assisted (SCA) techniques, based on a novel theoretical concept – SCA Loss Management (SCALom) theory.

Biography:

Nihal Kularatna is research-active in supercapacitor applications and power electronics. He has authored ten reference books and research monographs and contributed over 175 publications. He won the Post Graduate Research Supervision Excellence Award (2021) from the University of Waikato, Hamilton 3240, New Zealand, where he is employed as an Associate Professor. He won the NZ Engineering Innovator of the Year 2013 award for developing SCA techniques. He received the D.Sc. degree in 2015. Prior to moving to academia in New Zealand, he was the CEO of Arthur C. Clarke Institute in Sri Lanka.

Thermal Management of Photovoltaic Panel Using a Passive and Active Cooling Approach

Pravin D. Sawarkar* and Someshwar S. Bhakre

Visvesvaraya National Institute of Technology, Maharashtra, India

Abstract

Solar photovoltaic (PV) is a popular choice for renewable energy worldwide, but it often suffer relatively low efficiency due to the adverse effects of increased surface temperature caused by sunlight absorption. This rise in temperature converts solar energy into heat, leading to reduction in power output, energy efficiency, overall performance, and life of panel. To address this issue, implementing suitable cooling techniques becomes essential as they provide a promising solution to prevent excessive heating of PV panels and effectively lowers cell temperature. A comprehensive exploration of viable cooling methods is discussed, encompassing both conventional and cutting-edge solutions for effective cooling of PV panels. The various thermal management approaches for PV panels, including the use of phase change materials (PCM), water-based PVT/PCM systems and evaporative cooling is studied. When PCM is used, the temperature of PV panel can be maintained at 60°C, resulting in an increase in electrical efficiency while the reference panel temperature reaches 72-75°C. Similarly, the water-based PVT/PCM system is efficient in diverse environmental conditions which reduce the panel temperature to great extent from its peak temperature and an improvement in efficiency is seen. An experimental investigation with evaporative cooling in dry and arid climates demonstrates reduction in panel temperature, leading to enhancement in electrical efficiency. In addition to experiments, numerical investigations of the PVT/PCM system, incorporating a water container has been carried out. The improved results are obtained compared to the PV/PCM system in hot climatic conditions. Also, an optimized water container thickness for the PVT/PCM system is identified.

Biography:

Pravin D. Sawarkar graduated in Mechanical Engineering from Nagpur University in 1997, received Masters degree from Indian Institute of Technology Bombay, Mumbai in 2008 and

Ph D from Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai in 2018. He is in teaching profession since 1997. He has guided more than Ten M Tech dissertations and three research scholars are pursuing Ph D under his supervision. He is actively engaged in research in thermal science. His current fields of research are Heat transfer enhancement, Solar energy, Thermal management of photovoltaic panels, Battery thermal management system, Combustion engineering and research on Vortex tube. He acted as Reviewer in some International journals and conferences.

Atomic And Electronic Structures of Energy Materials Studied by In Situ Synchrotron X-Ray Spectroscopy

Chung-Li Dong[1*]

[1]Department of Physics, Tamkang University, Tamsui 25137, Taiwan

Abstract

Materials scientists are dedicated to addressing the rising global demand for sustainable and clean energy. Developing advanced renewable energy materials is essential for achieving environmentally-friendly approaches. To accomplish a zero-emission future, we must tackle the challenge from various angles, with a particular focus on advanced functional materials that enhance energy conversion, storage, and conservation efficiency. Improving the efficiency of current energy materials is straightforward, yet technically demanding. The physical and chemical properties of a material are closely tied to its atomic and electronic structures. Understanding these fundamentals, especially their response under working conditions is crucial for efficient engineering and practical utilization with superior performance. Synchrotron x-ray spectroscopies, such as x-ray absorption and x-ray emission spectroscopies, serve as powerful tools for studying the electronic states of energy materials. In situ techniques allow us to observe the dynamic changes in atomic and electronic structures during operation. The emerging field of scanning transmission x-ray microscopy, offering spatially resolved x-ray spectroscopy, holds promise for energy science exploration. This presentation will highlight the significance of x-ray spectroscopies in characterizing the atomic and electronic structures of energy material systems like artificial photosynthesis materials, advanced nanocatalysts, and smart materials. It also covers recent advancements in in-situ techniques, emerging characterization tools, and the Tamkang University (TKU) end-stations at the Taiwan Photon Source (TPS) 45A & 27A beamlines dedicated to energy science.

Biography:

Chung-Li Dong received his Ph.D. in Physics from Tamkang University in 2004. He conducted the postdoctoral research at the Institute of Physics, Academia Sinica, Taiwan, and Advanced Light Source, Lawrence Berkeley National Laboratory, USA during 2005-2009. In 2009-2015, he was an assistant scientist at the National Synchrotron Radiation Research Center. He is currently an associated professor at Tamkang University, Taiwan. His research focuses on the synchrotron-based and in situ/operando spectroscopic studies of electronic structures of advanced and energy materials.

Chemical Energy Conversion Processes Investigated by NMR

Anastasia Vyalikh

Technical University of Dresden, Germany

Abstract Not Available

Molecular Investigation on the Mechanisms of Nitrogen Transformation in Ammonia Utilization

Xi Jiang, Mengwei Yu and Zhihao Xing

Queen Mary University of London, London, UK

Abstract

As a flexible long-term energy carrier and zero-carbon fuel, ammonia (NH_3) is attracting increasing research attention. Ammonia utilisation and co-firing (with another fuel) can contribute to global decarbonisation. Reactive force field molecular dynamic simulation was performed in this study to elucidate the effect of NH_3 on cleaner energy conversion including pyrolysis and combustion applications from an atomic point of view. Sample results of molecular dynamics simulation of ammonia utilisation are discussed, providing understandings on the mechanism of N transformation pathways during coal/NH_3 co-pyrolysis, and on the pollutant formation in the co-firing of biomass (lignin) and ammonia including the mechanisms of NO_x suppression by lignin in the oxidation process.

Biography:

Jiang currently chairs the Division of Chemical Engineering and Sustainable Energy in Queen Mary University of London, UK. He was previously Professor of Mechanical Engineering and Chair in Energy Use and Transport in Lancaster University, UK (2009-2017). The expertise of Prof Jiang is primarily in energy/environmental engineering applications, using advanced modelling/simulation.

Developments in Cybersecurity for Critical and Renewable energy Infrastructure

Josef Schindler[1,2*], Karl Waedt[1] and Erkin Kirdan[1,3]

[1]Framatome GmbH, Erlangen, Germany;

[2]Friedrich-Alexander-University Erlangen-Nuremberg, Germany;

[3]Technical University of Munich, Germany

Abstract

Over recent years, cybersecurity attackers have increasingly targeted Information Technology (IT) and Operational Technology (OT) energy infrastructure. Incidents such as the BlackEnergy attacks in 2007, NotPetya in 2017, and a ransomware attack on US pipelines in 2021 underscore the growing threat. This heightened risk is further complicated by the potential of large-scale attacks that could incapacitate multiple energy facilities. The involvement of state-sponsored attackers accentuates the international and complex nature of this evolving threat landscape.

Regulatory authorities, particularly in the European Union, have been formulating more stringent cybersecurity legislation in response to these challenges. A significant trend is the broadened definition of "critical infrastructure," as demanded by directives such as the European NIS-2. This shift has prompted countries to revise and strengthen their national regulations, thereby expanding the list of facilities needing to adhere to rigorous security requirements.

This study provides an in-depth review of the substantial changes in EU regulation (NIS and NIS-2), particularly their impacts within member states such as Germany. The study also maps these regulatory modifications against past cyberattacks and the spectrum of existing threats. The goal is to offer a clear understanding of the evolution of regulatory responses to these cybersecurity incidents and threats and to suggest potential future directions for regulatory enhancements to ensure a more secure energy infrastructure.

Biography:

Josef Schindler entered Framatome as a PhD student after finishing his master degree in electrical power engineering in 2018. As member of the international research project DECENT, his focus was the optimization of sector coupling in decentralized power systems. An increasing share of his work was dedicated to cybersecurity, including several publications. As of 2021, Josef Schindler started as a member of the SMARTEST2 research project for cybersecurity, and as of 2022, he is now cybersecurity engineer at Framatome.

An Empirical Study of the Impact of Greenwashing in Developed Versus Developing Countries

Shahrin Saaid Shaharuddin, University of Malaya, Malaysia

Abstract not avaialble

Smart Conductive Hydrogel-based Gluten/Guar Gum for Eco-friendly Strain Sensor and Self-powered Device

Pornnapa Kasemsiri, Nattakan Jaroenthai and Somnuk Theerakulpisut

Khon Kaen University, Khon Kaen, Thailand

Abstract

In this study, a smart hydrogel based on gluten/guar gum (GG) copolymer containing a combination of additives was developed and applied as strain sensor and self-powered device. The mix proportions of smart hydrogel were designed using Taguchi method coupled with Grey relational analysis in order to determine an optimum mixture. L16 orthogonal array with three factors, viz. tannic acid (TA), glycerol and sodium chloride (NaCl) at four-levels each was chosen for optimization. Based on the results, the additions of TA and NaCl into smart hydrogel were the main factor in enhancement of self-adhesion ability, tensile strength and conductivity. The incorporation of glycerol into smart hydrogel could decrease the self-healing time which was observed in the range of 28.75-150 sec. Furthermore, the addition of glycerol also improved stretchability of the smart hydrogel. The best mix proportion of smart hydrogel was found to be 3.75 wt% TA, 30 vol% glycerol and 5 wt% NaCl. The best mixture of smart hydrogel showed the highest gauge factor (GF) of 0.61% at a stretchability of 665% and rapid self-healing at 70 sec. The obtained hydrogel could be applied to monitor human limb movements in a wide temperature range from -20 °C to 50 °C. Furthermore, it was successfully used as self-powered sensors that could produce electric current in the range of 2-8 µA.

Biography:

Pornnapa Kasemsiri is an Associate Professor of Chemical Engineering at Khon Kaen University in Khon Kaen, Thailand where she has been since 2012. During 2017-2018, she was a Postdoctoral Fellow at Tokyo Institute of Technology, Tokyo, Japan under supervision of Professor Shinji Ando. Her research interests span both biopolymers and smart materials. Much of her work has been on developing the biopolymers and nanocomposites for packaging, biomedical materials, self-powered materials and novel smart polymers. Dr. Kasemsiri has published over 80 research papers (h-index = 20, July 2023). This research has been exclusively funded by National Research Council of Thailand.

Development of an Innovative Daylighting Louver System Based on a ParametricControl Technique

Ahmad Eltaweel* and Islam Shyha

Edinburgh Napier University, United Kingdom

Abstract

Despite its abundance, solar energy has not been fully harnessed in buildings, particularly for daylight illumination. This underused benefit can be better utilized by using an innovative system to reduce electric energy consumption across the country. Furthermore, the advantagesof daylighting extend beyond energy savings to include improved well-being, productivity, and environmental impact. An innovative louvre daylighting system that can be parametrically regulated to redirect sunlight equally onto a building's floor will be developed. During typical working hours, the system aims to achieve the recommended daylight illumination level (European and CIE standards) for practically the entire floor space, making it a cost-effective daylighting option. Static louvers or manually controlled blinds can partly serve this purpose, while miscellaneous light pipes can achieve a much deeper daylight penetration, but they are bulky. To overcome such limitations, the proposed project will advance the function of louvers by a parametric control of individually angled reflective slats, therefore the ceiling of a room can be uniformly daylit, hence, to serve as a diffuse light source. The system's modelling analysis shows over 90% of the floor area (8-meter depth) can have a daylight illumination of 300-500 lux (based on CIE standard for reading and office work) for most of the typical working hours from 9 a.m. to 5 p.m.

Power Estimation for Thermoelectric Harvesters in Low and Ultra-Low Temperature Gradients through Dimensional Analysis

Simon Lineykin[1]*, Alon Kuperman[2], and Moshe Sitbon[1]

[1]Ariel University, Israel; [2]Ben-Gurion University, Israel

Abstract

Thermoelectric harvesters are gaining importance as power sources for low-power electronic devices in remote areas. Traditional battery-dependent systems face challenges such as frequent maintenance and environmental impact. This study focuses on low and ultra-low temperature gradients for waste heat utilization. The conventional mathematical model considers the Seebeck and Peltier effects, heat transfer, electrical current flow, and Joule internal heating due to the resistivity of thermoelectricmaterials. The convection heat exchange in heating plays a key role in harvesting. The model has eight uncertain parameters, causing a higher overall error in the low-power estimation. This limits the model usage. The dimensional analysis method proposed here improves modeling thermoelectric harvesters operating at low and ultra-low temperature gradients. The proposed approach reduces the number of model parameters, focusing on accurately measurable ones, to mitigate minor output power range errors. A guide for selecting the optimal thermoelectric module for a given thermal path is also introduced. This method allows the estimation of maximum power generation based on environmental conditions and known thermal routes regardless of thermoelectric module information. Experimental validation using different thermoelectric modules and thermal paths confirms the feasibility of the proposed model. Results align closely with the theoretical analysis, validating the dimensional analysis approach. The proposed method provides valuable insights for designing and optimizing thermoelectric harvesters, empowering researchers and engineers to select suitable modules and enhance performance.

Biography:

Simon Lineykin is a Senior Lecturer at the Department of Mechanical Engineering and Mechatronics, Ariel University of Samaria, Israel. He obtained his Ph.D. from the Department of Electrical and Computer Engineering at Ben-Gurion University of the Negev in 2006 while holding an academic degree in mechanical engineering. Currently, Simon leads the Renewable Energy Research Laboratory in the Department of Mechanics and Mechatronics at Ariel University. His research encompasses thermal, electrical, and mechanical processes, primarily focusing on renewable energy, direct energy conversion systems, thermoelectric devices, ultra- low noise electronic systems and sensors, electro-optical systems, active thermal management, and mathematical modeling of physical phenomena.

Keynote Presentation

Multi-vector Energy Storage for Carbon Neutrality

Yulong Ding

Birmingham University, UK

Yulong Ding is the founding Chamberlain Chair of Chemical Engineering at the University of Birmingham and Director of Birmingham Centre for Energy Storage. His current research covers both fundamental (multiphase transport phenomena across length scales) and applied (new energy conversion and storage technologies) aspects. He invented liquid air energy storage technology and led the initial stage of its developments and validation, which is commercialized by Highview Power, a UK engineering company. He developed composite phase change materials for thermal energy storage and associated large-scale manufacture technologies, leading to large scale commercial applications with a total installation of >300MW / >1.2GWh so far. His work on passively cooled container technology has been on large scale commercial demonstration for cold chain transportation applications.

Oral Presentation

Exploring the Significance of Hydrothermal Liquefaction Process in Biomass Conversion and the Prospects of Utilizing Waste Process Water in Diverse Sectors: An Investigative Study

Halil Durak

Van Yuzuncu Yil University, TURKEY

Abstract

Hydrothermal liquefaction (HTL) represents a versatile and promising thermochemical process that exhibits the capacity to effectively convert wet biomass and organic waste into a valuable liquid bio-oil. The hydrothermal liquefaction process operates on the principles of high temperature, high pressure, and the presence of water. Biomass or organic waste feedstock, typically with a high moisture content, is subjected to temperatures ranging from 250 to 400 degrees Celsius and pressures between 10 and 25 megapascals (MPa). At these conditions, the complex organic compounds within the feedstock undergo thermal decomposition and chemical reactions, leading to the formation of a liquid bio-oil. This technology holds immense potential across various domains, including biofuel production, chemical feedstocks, waste recycling, and resource efficiency. Consequently, HTL plays a pivotal role in sustainable waste management and the advancement of an environmentally conscious and resource-aware society. The applications of HTL encompass a wide array of fields, encompassing biofuel production, chemical raw materials, waste evaluation, resource efficiency, and sustainability. Notably, during HTL experimentation, residual wastewater following the extraction process contains numerous chemical compounds that cannot be effectively recovered through conventional chemical methodologies. The accumulation of these chemical compounds poses environmental challenges, necessitating mitigation strategies. One viable solution involves the utilization of this waste process water in agricultural applications, including fungi control and algae cultivation. This approach serves the dual purpose of preventing

the release of harmful chemicals into the environment while concurrently generating economic benefits.

Biography:

Dr. Halil DURAK is a researcher and academician focused on Chemical Engineering and Technology, Environmental Chemistry and Technology and Renewable Energy Systems. In addition to his research, Dr. Halil DURAK is a dedicated educator and has taught Chemistry at various levels for over two decades, advising numerous undergraduate and graduate students in their research. Dr. Halil DURAK's contributions to science and education have earned him numerous awards and accolades, including several research fellowships, publications in high-impact journals, and invitations to speak at international conferences. Dr. Halil Durak is still a Professor at Yuzuncu Yıl University.

Renewable Energy Proliferation Trough Energy Community: Analysis of a Case Study from Italy

Barbara Marchetti*, Matteo Vitali[a], Francesco Corvaro[b] and Giovanni Biancini*

*Università degli Studi eCampus, Italy, Saipem Spa, France

Univerità Poiltecnica delle Marche, Italy

Abstract

Renewable energy communities have been gaining momentum around the world as a way to promote sustainable development and combat climate change. These communities are typically composed of individuals, businesses, and organizations that come together to invest in and promote the use of renewable energy sources such as solar, wind, and hydraulic power. This article focuses on the benefits that renewable energy communities (REC) bring to the territory with a capillary diffusion of renewable energy systems, tackling different issues like local depopulation, increasing energy prices and lack of jobs while reducing greenhouse gas emissions and improving air quality.

The article draws on a case study from the center of Italy, where a local municipality expressed interests in the self-production of clean energy through the use of solar panels and hydraulic turbines. Such production systems will be administered in a new REC that involves the community actively.

The analysis of the consumers and prosumers energy needs, as well as the quantification of the exploitable production from the new renewable generators installed, show that a total of 3.26 GWh/year that can be shared up to 640 families or 50 local businesses besides the municipality consumptions.

Biography:

Barbara Marchetti is Associate professor working on the following main research topics: assessing the impact of renewable energy systems on local sustainability; energy production from renewables; LCA, innovative technique for recycling; numerical and experimental study of multiphase flow of hydrocarbons. She was member of the Steering Committee of the European Technology Platform on Renewable. She was chairman in two editions of the international workshop: "The Challenges of Climate Change" held at Catholic University of America (2017-2019).

Towards 26% Efficient Solar Cells in Mass Production with Doped Poly-Silicon Passivating Contacts

Daniel Macdonald Peiting Zheng, Sieu Pheng Phang, Jie Yang, Zhao Wang, Rabin Basnet, Di Kang, Xinyu Zhang and Hao Jin

Australian National University, Canberra, Australia; Jinko Solar, China

Abstract

Doped poly-silicon passivating contacts have emerged as a key technology for the next generation of industrial crystalline silicon solar cells beyond the current industry-standard p-type PERC cells. Their outstanding surface passivation and low contact resistance have enabled very high efficiencies in the laboratory, whilst their high compatibility with existing production technologies has led to many PV manufacturers trialing this technology in pilot lines, with several already moving to mass production.

To date, the industrialization of poly-silicon contacts has been limited to the original "TOPCon" cell design – n-type cells with a full-area n+ doped poly-Si contact on the rear, and a boron-diffused p+ junction on the front. Large-area TOPCon cells fabricated in industrial R&D laboratories have achieved multiple efficiency records over the past few years, with the most recent mark of 26.4% being set by Jinko Solar in December 2022. Despite this rapid progress, identifying the best architecture and processes to achieve above 26% in mass production with poly-silicon contacts remains an open challenge, and may require alternatives to the standard n-type TOPCon structure. In this work we will review recent progress in the industrialization of poly-silicon contacted cells, and consider possible future directions, including alternative architectures with p+ poly-silicon contacts, rear-junction cells, and interdigitated back contact cells.

Biography:

Daniel Macdonald completed his PhD in silicon solar cells at ANU in 2001 and has over 20 years' experience in silicon solar cell research, spanning materials, device design and fabrication, and advanced characterization. He currently leads a team of 25 postdoctoral fellows and research students, has published over 400 papers in the field, and has led projects valued at over AU$20 million, including large industry-supported projects. He has held three prestigious ARC Fellowships and is a leading expert in n-type silicon solar cells and their commercialization, including poly-silicon contacted solar cells.

Renewable Energy and Global Challenges Associated with the Pursuit of Well-Being

Le Van

University of Economics Ho Chi Minh City (UEH), VietNam

Abstract

This study investigates how renewable energy is challenged by current global volatilities. As happiness tends to be the major goal of human beings, we assess how renewable energy is affected by global challenges associated with the pursuit of well-being. We examine the linkage between the INDXX renewable energy index (REN) and the Twitter's daily happiness sentiment index (DHS). This selection matches our research objective that (i) REN represents the performance of renewable energy firms, covering both economic and environmental aspects of sustainability; and (ii) DHS reflects the well-being goal. We use the bivariate generalized autoregressive conditional heteroskedasticity modeling along the conditional correlation process to assess the interaction between daily changes in REN and DHS from 30 September 2015 to 13 May 2022. We find that

DHS positively affects the performance of renewable energy firms. Whilst the empirical modeling does not reveal a significant impact ofREN on well-being. The importance of happiness is strongly affirmed in terms of its optimal holding weight in pursuit of both renewable energy and well-being objectives. Our findings indicate the tremendous role of happiness in sustainable development goals. In which, the well-being goal shall be favorable along sustainability.

Biography:

Lecturer and PhD candidate at University of Economics Ho Chi Minh City (UEH), with a wide range of research interests such as well-being, sustainable development, financial markets, and multidisciplinary topics. Strong professional backgrounds in financial economics, laws, and public policy with more than 30 published works, multiple conference presentations, andmembership in the American Finance Association (AFA). Highly efficient and productive researcher with original thinking. Represented Vietnam to attend the Global Energy Meeting(GEM) 2023 in Boston, MA, USA to deliver his study on the connection between solar energyfirms and happiness sentiment in pursuit of sustainability.

Nutrient Content of Liquid Organic Fertilizer

Elisa Azura Azman, Sanjeev M.P. Ramarao, Roslan Ismail, Nor Elliza Tajidin, Borhan Abdul Haya

Universiti Putra Malaysia Serdang, MALAYSIA, Institut Tanah dan Ukur Negara (INSTUN), Perak, MALAYSIA, Universiti Malaysia Sabah, Sabah,MALAYSIA

Abstract

The Malaysian government is confronted with issues of handling food waste, which creates greenhouse gases in landfills. The valuable nutrient in food waste can be used to achieve impressive fermentation performance by producing liquid organic fertilizer, which helps improve soil characteristics such as low cation exchange capacity, pH, and mineral nutrient content which directly cause the productivity of crops to become low. Therefore, the objective of this study was to characterize the liquid fertilizer from food waste. The food waste derived from unmarketable vegetables and fruits was identified and collected from the nearest wet market and incubated in the container with a ratio of 1: 2: 0.1 (10 kg food waste: 20 L water: 1 kg Inducer) for 30, 45, and 60 days. There have 3 types of inducers; yeast (Y), brown sugar (BS), and shrimp paste (SP) to boost the fermentation process. Food waste with no inducer acts as a control. The liquid as a product from the mixture was sampled and filtered on 30, 45, and 60 days of fermentation and analyzed for pH, EC, macro, and micronutrients. These experiments were laid in a randomized complete block design (RCBD) and replicated three times. Liquid Organic Fertilizer using yeast as an inducer on 60 days of fermentation gave the highest nitrogen (0.95%), phosphorus (0.31%), potassium (1.68%), zinc (9.03 ppm), copper (0.23 ppm), and manganese (9.03 ppm). Besides, this treatment showed appropriate pH and EC values for the plants.

Biography:

Elisa Azura Azman pursued a Doctor of Philosophy (Ph.D.) from The University of Tokyo, Japan (2016). She has actively engaged in international and local seminars, posters, and lectures and served as moderator/evaluator. She started her career as an academician in 2017 at the Universiti Malaysia Sabah and moved to Universiti Putra Malaysia (Faculty of Agriculture) in 2019. Her research interest is in the field of agronomy, organic farming, sustainable farm system, and fertilizer management for sustainable and quality agriculture food production. She has published several academic writings related to her field in 22 journals and 2 chapters in books.

A Direct Hybrid with Power Management for Aviation Applications

Caroline Willich*, Christiane Bauer, Robin Fonk, Tobias Graf and Pia Hoenicke

Ulm University, Germany

Abstract

Fuel cells are promising for reducing emissions in transport on ground and in aviation [1]. For meeting varying power demands, the fuel cell can be combined with a battery in a hybrid system. Peaks in power can then be covered by both power sources and the system can be designed with a smaller fuel cell than otherwise necessary, reducing costs. The most common approach is to connect the fuel cell and the battery with the help of one or two DC/DCs in an indirect hybrid. The DC/DC adapts the voltage levels of the fuel cell to the voltage level required at the load and controls the power flow according to the needs of each system offering a high operational flexibility. In a direct hybrid a different approach is used. Here the fuel cell and the battery are coupled directly without the help of a DC/DC. In this configuration the power distribution and the system voltage levels are determined by the fuel cell and battery characteristics. The paper examines the behavior of the hybrid depending on the state of charge of the battery and for aviation applications the influence of low surrounding pressures. The system behavior was examined experimentally as well as theoretically. In order to control the power provided by the fuel cell and the battery at different load phases a power management was developed that makes it possible to choose which power sources are used during different load phases.

Biography:

Caroline Willich is a group leader at the Institute for Energy Conversion and Storage at Ulm University. After studying mechanical engineering at the Technical University of Munich (TUM) and the Escuela Tecnica de Ingenieros Industriales in Madrid (ETSII), she obtained her doctorate from the University of Stuttgart while working at the German Aerospace Centre (DLR). After leading several projects at DLR and a post doc at the University of Cambridge, UK. She joined Ulm University in 2017. Her main field of research is fuel cell systems. She is involved in several research projects.

Energy and Water Management Systems for Agro-Development of RuralCommunities

Doris Sáez, University of Chileand Instituto Sistemas Complejos de Ingeniería, Chile

Abstract

In Chile and other developing countries, many rural communities lack adequate access to essential services (water and electricity), impacting their quality of life. Moreover, the access and management of water and energy are conditioned by several territorial aspects, with water shortage among the main ones. Thus, the integrated optimization of energy and water is required to improve product development in rural areas, ensure water resources' sustainability, and minimize energy access costs.

In this work, robust predictive control schemes based on fuzzy prediction intervals for controlling and coordinating energy-water microgrids are derived considering the dynamic relations and stochasticity of the renewable energy, water resources, energy-water consumptions, the aquifers' water level and the water shortage. The proposed prediction interval, based on fuzzy systems, is derived for jointly characterizing the non-linearities, dynamics and uncertainties associated with the variability and stochasticity of the energy-water microgrids. The coordination of multiple energy-water MGs also is studied using predictive control schemes for minimizing the microgrid costs ensuring the fulfilment of shared water requirements. Using the proposed controllers based

on prediction intervals, the performance of energy-water MGs is studied and analyzed under different scenarios (water shortage, shared/non-shared wells/aquifers).

This methodology focuses on maximizing the benefits in terms of efficiency (co-optimized water and energy resources) and effectiveness (applied to multiple resources and consumptions) of the solutions.

Biography:

Doris Sáez (Senior Member, IEEE) received her M.Sc. and Ph.D. degrees in electrical engineering from the Pontificia Universidad Católica de Chile, Santiago, Chile, in 1995 and 2000, respectively, and is an Associate Researcher at Instituto Sistemas Complejos de Ingeniería (ISCI). She is a Full Professor with the Department of Electrical Engineering and the Head of the Indigenous People Program, Faculty of Mathematical and Physical Sciences, University of Chile, Santiago. Her research interests include predictive control, fuzzy control design, fuzzy identification, and control of microgrids. She also serves asan Associate Editor for the IEEE Electrification Magazine.

Applications of Nanofluids in Solar Energy

Awatef Abidi

King Khalid University, Saudi Arabia; Monastir University, Tunisia; Sousse University, Tun isia

Abstract

Solar energy technology is considered as one of the ideal candidates, which directly converts solar energy into electricity and heat without any greenhouse gas emissions. Performance of solar energy systems is subject to the type of the working fluid that they use for solar energy conversion and transportation. Utilizing nanofluid as a potential heat transfer fluid with superior thermophysical properties is an effective alternative to enhance the thermal performance of solar energy systems. Hence, investigating the performance of nanofluid-based solar energy harvesting devices is of great importance. This work presents an overview of the recent advancement in nanofluid-based solar energy harvesting devices and how various parameters such as nanoparticle size, concentration, shapes, and nanofluid flow rates can be manipulated efficiently to improve the efficiency of the harvesting devices. Comparison between the nanofluidic systems, and the conventional ones is performed in order to gain a deeper insight into the advantages of using nanofluids. Finally, the challenges of using nanofluids in solar energy devices are discussed.

Biography:

Awatef Abidi is an Assistant Professor in the Physics Department, College of sciences at King Khalid University Kingdom of Saudi Arabia. She received her Ph.D. degree in Energetic Engineering in 2011 and obtained her Habilitation for Supervising Doctoral Research (HDR) from National Engineering School of Monastir at University of Monastir, Tunisia. Her research interests cover computational fluid dynamics, micropolar fluid, nanofluid, hybrid nanofluid and heat and mass transfer in microchannels, nanofluid and solar energy, phase change materials and porous media heat transfer.

Alternative Clean Energy: Lignite-Waste Biomass Mixture

Aydan Aksoğan Korkmaz*

Malatya Turgut Özal University, Turkey

Abstract

Energy is one of the most important basic needs of society. In developing and underdeveloped countries, most of this energy need is met by fossil energy resources. These resources are not suitable for continuous use as they are both limited and harm the environment. For the continuity of energy, it is necessary to make maximum use of renewable energy sources such as biomass. It can be converted into solid, liquid and gaseous fuels by using some conversion techniques such as direct burning, pyrolysis and gasification. The high content of H in biomass is used as a hydrogen source during pyrolysis with coal. H and OH radicals released from biomass during pyrolysis support the cracks in the aromatic rings of the coal. By burning the solid product obtained from the pyrolysis of coal and biomass, it is possible to reduce the contents such as SO_2 and NO_x that pollute the atmosphere. In this study, pyrolysis of lignite and walnut shell at different mixing ratios and temperatures was carried out. The energy values and C, S, N contents of the obtained solid product were determined. It has been determined that there are positive changes in smokeless fuel with the increasing biomass ratio.

Biography:

Aydan Aksoğan Korkmaz was born in Malatya in 1976. She completed her Mining Engineering undergraduate education in 1998, her master's degree in 2007 and her doctorate in 2017. She worked as an academician at İnönü University between 2001-2019. In 2019, she transferred to Malatya Turgut Özal University. She became an Associate Professor in Mining Engineering in 2022. She has many publications on renewable energy and fossil fuels.

Poster Presentation

High Performance Non-Aqueous Organic Redox Flow Battery inAmbient Condition

Sandeep Kumar Mohapatra, Kothandaraman R* and Sankararaman S*

Indian Institute of Technology Madras, India

Abstract:

Redox flow battery (RFB) is a preferred energy storage option for grid stabilisation and energy arbitrage as it offers energy and power decoupling [1,2]. In contrast to aqueous RFBs (ARFBs), nonaqueous RFBs (NARFBs) could offer high energy densities due to the wider electrochemical window of the solvents used, which could handle high and low voltage organic redox couples without undergoing electrolysis [3]. In this study, a RFB based on benzyl viologen hexafluorophosphate [BV (PF6)2] as anolyte and N-hexyl phenothiazine [HPT] as catholyte demonstrated. A cell operated with mixed electrolyte (1:1) containing 0.2 M [BV (PF6)2] and 0.2 M [HPT] delivered a coulombic efficiency (CE) of 95.3 % and energy efficiency(EE) 53%, with nearly 68.9% material utilisation at 40 mA cm^{-2} current density.

Keywords: Non-aqueous redox flow battery, Benzyl viologen, N-hexyl phenothiazine.

Biography:

Sandeep Kumar Mohapatra is born on 23 rd. March 1995 in Odisha, India. Currently, He is working as a research scholar under guidance of Prof.S.Sankararaman in IITMadras, Chennai. He is working on organic redox flow battery as energy storage device to reduce the use of inorganic material.

Oral Presentation

Real-time Thermal Energy Harvesting from Solar Radiation in Malaysia at Low-Temperature Difference

Muhammad Nazri Rejab

Universiti Tun Hussein Onn Malaysia, Malaysia

Not available

Nanostructured Mixed Oxides with an Ordered Morphology for Energy and Environmental Applications

Elisa Moretti

Ca' Foscari University of Venice, Italy

Abstract

Nowadays, one of the main technological challenges that we are facing is the ability to provide a sustainable supply of clean energy and, among all renewable sources, solar energy displays the greatest potential.

Titania based systems are the most widely studied and applied photocatalysts. A growinginterest has recently emerged on photoenergy applications of ceria, since its experimental bandgap is very close to that of TiO_2, with a decreased recombination rate of electron-hole pairs. Recently, the development of novel synthetic strategies has led to the preparation of nanostructured materials displaying unique properties compared to the bulk counterpart systems, with controlled and tunable morphologies able to enhance the activity and selectivity of a catalytic process.

This talk will focus on the importance of tuning the morphological features of a catalyst as a strategy to improve the catalytic activity, focusing on how rationally designing ceria-based materials can lead to morphologies and micro/nanostructures suitable to enhance the catalytic performance. The talk will discuss some energy and environmental applications that can be addressed by ceria-titania nanosystems, highlighting their structure-reactivity relationship. Photocatalytic H_2 production and purification will be presented as successful cases history.

Biography:

Elisa Moretti is Associate Professor of Inorganic Chemistry at the Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice (Italy). After her PhD Degree in Chemistry at Ca' Foscari, she worked at the University of Malaga and the Institute of Materials Science CSIC-University of Seville (Spain) for a post-doctoral experience. EM is leading a multidisciplinary group focusing on the development of advanced 0-2D nanostructured inorganic materials for energy and environmental application. EM is also co-founder and scientific supervisor of the Spinoff ChEERS - Circular Economy for Energetic Recycling Solutions, for sustainable upcycling and valorisation of industrial/agri-foodwastes.

Condition Monitoring and Control of Wind Power Systems with Machine Learning

Xiandong Ma, Lancaster University, United Kingdom

Abstract

The presentation focuses on condition monitoring and control of wind power systems spanning from **fundamental research to practical applications**. Condition monitoring plays an increasingly important role for reliable and predictable operation of the wind power systems, thus reducing their operation and maintenance costs. This requires interdisciplinary research to develop new physical-knowledge based analytical models and data-driven condition monitoring techniques to create new methods for asset management of the wind power system. Our research has been centered on the study of machine learning data-driven models for effective condition monitoring using an intelligent and integrated approach. This presentation will describe the journey in the development of smart condition monitoring and control techniques from conception in an academic environment to practical deployments at Lancaster University.

Biography:

Xiandong Ma is a Reader in Power and Energy Systems in the School of Engineering at Lancaster University, UK. He is internationally known for his work in modelling, optimization and control of smart/micro grids with renewable energy resources, and intelligent condition monitoring of energy systems. His work has been supported by UK EPSRC, Royal Society, Leverhulme Trust, ERDF and industry. He has published >140 papers in leading journals and conferences in power and energy systems. Dr Ma is an UK Chartered Engineer, a Fellow of the Institution of Engineering and Technology, and a Fellow of the Higher Education Academy.

Enhanced Voltage and Frequency regulation via an Intelligent Droop-based Control Strategy in an Islanded Microgrid

Shu Godwill Ndeh[1*], Divine Khan Ngwashi[2], Lawrence Kiprono Letting[3]

[1, 2]University of Buea, Cameroon; [3]Moi University, Kenya

Abstract

AC microgrids are usually made up parallel-connected distributed generators (DGs). Often, these DGs are predominantly renewable energy sources (RES) and interfaced with inverters. Every one of these inverter-based DG has a distinct droop characteristic. As seasons change, needs change and so the demand for power also changes. These changes in load power demand cause a mismatch between power generation and consumption. Based on the droop characteristics of the inverter-based DGs, this mismatch can alter the frequency and voltage output. When the load change becomes significantly large, the inverter-based DGs fail to maintain the grid stability. Furthermore, disparity in line impedance causes the generalized droop control (GDC) strategy to fail to share the load reactive power demand effectively among the DGs. As a result of this, voltage stability is threatened. To address these challenges, this paper proposes a particle swarm optimization (PSO)-based adaptive neuro-fuzzy inference system (ANFIS) droop-based control strategy. This control strategy does not depend on the line impedance as well as the droop characteristics of the inverter-based DGs. To validate this proposed strategy, an islanded microgrid composed of two inverter-based DGs and a load is modelled in the MATLAB/Simulink environment. Several simulations are run while varying the load. In addition, the performance of GDC, ANFIS and ANFIS-PSO droop-based control strategies are compared. The results show that ANFIS-PSO performs best in maintaining the voltage and frequency within their set points regardless of the load changes

and impedance disparity.

Biography:

Shu Godwill Ndeh was born on April 11, 1988, in Wum, North West Region of Cameroon. He received his BEng and MEng Degrees in Industrial Engineering from the University of Douala, Cameroon in 2009 and 2011 respectively. In 2012 He worked in a marine engineering-based company and moved to serve as an assistant lecturer in several universities from 2016 to 2022. He is currently a PhD candidate in Power Systems Engineering at the University of Buea, Cameroon on an exchange program at Moi University, Kenya. His research interest is operation and control of microgrids and smart grids.

The Impact of Leading-Edge Deflection Angle on the Performance of Horizontal Axis Wind Turbine Model

Aktham Mansi and Ahmet Z. Sahin

Istanbul Technical University, Istanbul

Abstract:

Recently, wind energy has gained widespread recognition as a prominent renewable energy source. The utilization of small-scale horizontal axis wind turbines (HAWT) for generating electricity has emerged as a feasible solution. While notable advancements have been made in the wind energy field, there remain spaces for enhancing efficiency, reducing costs, and optimizing energy extraction. The study mainly discusses the examination of the parametric design and efficiency analysis of a three-blade HAWT model. The investigation incorporates the robust method, namely the blade element momentum (BEM). The impact of leading-edge deflection angles on the performance of HAWT is investigated. Three angles are studied, 3° , 6° , and 8°. The performance of the 3-D rotor is determined using QBlade software. Finally, the annual energy production (AEP) is estimated for both designs in specified regions in Türkiye, Izmir, Bursa, and Bilecik. The Weibull distribution is used to find the annual energy (kWh/year) using the Weibull scale parameter (A, m/s) and shape factor (K) values provided in the literature for each region. A comparative study is employed between both designs to find the efficient blade design based on the output power and annual energy production (AEP). The results show that the design with a deflection angle of 6° has a 12% better power coefficient, output power, and higher annual energy output compared with the first design. However, both designs are suitable to satisfy the energy desired by individual residences or small businesses.

Biography:

Aktham Mansi is a dedicated aerospace engineer with expertise in aerodynamics, wind turbine design, and computational fluid dynamics (CFD). Mansi currently pursuing a Master's degree in Aerospace Engineering under the guidance of the distinguished Professor Ahmet Z. Şahin at Istanbul Technical University. Aktham holds a Bachelor's degree in Aeronautical Engineering and a Master's degree in Mechanical Engineering. Mansi has conducted a research on small-scale horizontal axis wind turbines, published in reputable journal, and demonstrated proficiency in various software and numerical techniques for wind turbines.

Worldwide Climate and Justice Education Week 2024

David E. Blockstein and Eban Goodstein

Bard College, USA

Abstract

Bard College invites all to participate in the Worldwide Climate and Justice Education Week (Climate Ed Week) the first week of April 2024. It is a coordinated global educational event to engage students in interdisciplinary learning (and action) on climate, clean energy and other just solutions. The purpose is to show students that regardless of their discipline, they can be involved in climate repair. 2023-24 is the inaugural year of the Climate Ed Week but the 5th year of the project, which has included over 700 events reaching nearly 100,000 people in more than 70 countries. There are two general types of activities: MakeClimateAClass and MakeClimateAnEvent. The content of each activity is determined by the participating educators. Events in previous years have included Panels and discussion, Community Speakers. Film, Games, Poetry, Performances - plays, comedy, music, and art exhibitions. To MakeClimateAClass, educators spend at least 30 minutes of a class session discussing the connection between the subject of the course and climate change, solutions or justice. We encourage discussion about climate related careers. Bard provides certificates for participating institutions, organizers and attendees, a Communication Kit, bi-weekly webinars, connections with participating educators and organizers, scripts for short plays, introductory and concluding videos for events, evaluation forms, assistance with promotion and MORE.

Biography:

David Blockstein, Ph.D. co-directs the Worldwide Climate and Justice Education Week. He has 30+ years of national leadership on science and environmental policy, climate change and energy education, biodiversity, sustainability, and diversity and inclusion. He co-founded the US National Council for Science and the Environment (NCSE), Council of Environmental Deans and Directors (CEDD), Council of Energy Research and Education Leaders (CEREL), US Partnership for Education for Sustainable Development, and Association for Environmental Studies and Sciences (AESS). Blockstein is the co-author of The Climate Solutions Consensus: What We Know and What to Do About It (2010).

Why Humans are Not Responsible for Global Warming

Digby D. Macdonald

University of California at Berkeley, Berkeley, CA

Abstract

The scientific viability of the Anthropogenic Global Warming Hypothesis (AGWH) has been evaluated in terms of the Causality Principle (CP), which is the foundation of scientific philosophy. While the CP has a strict mathematical basis in Cauchy's theorem, the colloquial form of the CP is most appropriate especially when presenting it to a general audience. In this form, the CP may be expressed as: "Every effect has a cause, and the cause must precede the effect". Furthermore, "for a complex system comprising a series of processes, if any step is non-causal then so is the entire process". Based on the available ice-core data from the Vostok Station in Antarctica, the relationship that is expressed by the AGWH (that rising CO_2 concentration in the atmosphere is responsible for global warming (GW) as reflected in the rise in temperature) is noncausal because the alleged cause (the change in the atmospheric $[CO_2]$) lags the change in the temperature in the experimental record, in violation of the CP. Since the AGWH represents the foundational hypothesis of current climate science (CS), it is concluded that CS and the models that have been developed, based on the AGWH, to predict future GW lack a valid scientific basis. It is concluded that the anthropogenic release of CO_2 into the atmosphere cannot be responsible for the rise in

temperature. The reverse process is causal; that is, a rise in temperature gives rise to an increase in CO_2 in the atmosphere, which is wee-described by Henry's law.

Biography:

Macdonald is a native of New Zealand, a naturalized US citizen, and is a Professor in Residence in Nuclear Engineering and Materials Science and Engineering, University of California at Berkeley. He specializes in the growth and point defect structures of passive oxide films on metal surfaces and developed the Point Defect Model for describing the physico-electrochemistry of such systems. He developed the modern theory of stress corrosion cracking, in terms of the deterministic Coupled Environment Fracture Model and is a pioneer in the modern form of Electrochemical Impedance Spectroscopy for exploring the mechanisms of electrochemical reactions.

Coordinated High-Speed Voltage Control in Real-Time Unobservable ActiveDistribution Systems

Anamitra Pal*, Behrouz Azimian, and Dhaval Dalal

Arizona State University (ASU),Tempe, USA

Abstract:

Residential solar photovoltaic (PV) systems are integral for achieving the carbon neutral goals for 2050. At the same time, power utilities, who are responsible for the reliability and stabilityof our electric grid, are often unaware of the extent of behind-the-meter (BTM) solar PVpenetration. In the absence of real-time visibility and adequate control, the increasing proliferation of residential PV systems can play havoc with the distribution system voltage. Our research alleviates this concern by employing system-wide state information obtained at high speeds using machine learning to optimize reactive power regulation for achieving coordinated,robust, and fast control of residential PV systems.

Real-time monitoring of active distribution systems is essential in implementing the required control measures. Although phasor measurement units (PMUs)/µPMUs can provide sub-second situational awareness, equipping the entire distribution network with large numbers of PMUs/µPMUs is not economically feasible for modern power utilities. To overcome this challenge, we leverage Deep Learning to gather system-wide information from a limited number of PMUs/µPMUs. By employing Deep Learning, power utilities can monitor their network and make informed decisions while optimizing their investments in PV resources to effectively address potential grid challenges. This talk will describe how such a system can be implemented while considering the diverse attributes of modern distribution systems.

Biography:

Anamitra Pal is an Associate Professor in the School of Electrical, Computer, and Energy Engineering at Arizona State University. His research interests include data analytics with a special emphasis on time-synchronized measurements, artificial intelligence-applications in power systems, renewable generation integration studies, and critical infrastructure resilience. She has received the 2018 Young CRITIS Award for his contributions to the field of critical infrastructure protection, the 2019 Outstanding Young Professional Award from the IEEE Phoenix Section, and the 2022 NSF CAREER Award.

Evaluating Power Generation and Direct use with Green Energy Resources

Shah Kabir, Jose benavides, Pushpesh Sharma and Ahmed Al Saedi

Incendium Technologies, USA; University of Houston, USA; Schlumberger, Iraq

Abstract

Closed-loop fluid circulation in wellbores has become attractive for extracting the earth's thermal energy. Recent studies with analytical and numerical models show that geothermal gradient and well depth constitute the two most consequential items in fluid output temperature at the surface.

This presentation demonstrates a novel strategy for managing geothermal-gradient cooling. Mitigating the geothermal gradient cooling issue becomes feasible by adopting another energy source, such as solar or wind, with a day/night cycle over the years. This cyclical strategy entails fluid circulation at night and the daytime operation of solar or wind sources. Well-depth and geothermal gradients provide the necessary guidance about selecting the geographic area for power generation or hot-water production to meet various industrial needs. In this regard, economic tools, such as Net Present Value and Levelized Cost of Electricity, objectively provide the required business guidance.

Here are some of the lessons learned considering a 20-year power-generation period. Retaining the near-wellbore geothermal gradient becomes essential for ensuring about 130°C for power generation. This objective is attainable with a 12-h fluid-circulation cycle by juxtaposing a second well. A solar/wind source for a day/night cycle is also financially attractive. Contextually, in this energy transition phase, a power grid also presents an economic value proposition. Direct industrial usage in low-geothermal prospects also becomes economically viable to generate hot water, especially in repurposed abandoned wells. These industries, among others, include food and agriculture, requiring 60 to 85°C.

Biography:

Shah Kabir is an advisor at Incendium Technologies, LLC. In his 40+ years career, he worked at Schlumberger, Chevron, and Hess, and upon retirement, taught petroleum engineering at the University of Houston for about five years. He has published 135+ journal articles and several books. His expertise includes fluid flow and heat transfer in wellbores, reservoir engineering, and, lately, green energy resources, particularly harnessing thermal energy and carbon sequestration.

Caustic Aqueous Phase Electrochemical Reforming (Caper) for Process Intensified Hydrogen Production

Su Ha, Washington State University, Pullman, WA, USA

Abstract not available

Reliability of Offshore Wind Turbine Support Structures

Srinivas Sriramula

University of Aberdeen, Scotland, UK

Abstract

There is an extensive interest in quantifying the performance expectations of offshore wind turbine structures. Such an understanding is considered to be essential for improving the life

cycle estimation parameters and to develop risk-based inspection maintenance and management regimes. However, the uncertainties existing at multiple stages in the material, geometric and loading characteristics and their interactions complicate the probabilistic approaches that prioritise reliability estimation. The need to focus on multi-load combinations with numerical modelling in a computationally efficient pathway brings in many research challenges. This paper will focus on reliability computations of both the fixed and floating wind turbine support structures offshore, identifying the key progress towards rational estimation of partial safety factors. By implementing automated reliability computation schemes with a combination of aero-hydro-servo-elastic solvers and numerical analysis, demonstrative case studies will be discussed to highlight the practicality. The relevance of machine learning for physical failure representation and opportunities for enhancements in current practices will be highlighted.

Biography:

Sriramula is a Chartered Engineer (CEng, MIMechE) with research interests in the development of data-driven risk and reliability modelling approaches for structural systems. He is currently a Reader in the School of Engineering at the University of Aberdeen. He has joined as a Lecturer in August 2009, before becoming a Senior Lecturer in August 2017. Prior to that, he was a Postdoctoral Researcher at the University of Surrey working on CREDO (Composites Reliability from Engineering Design Optimisation) project. Dr Sriramula has published over 90 peer-reviewed publications in journals, conferences and as book chapters.

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