UNITED Scientific Group
A non-profit organization

GEM-2023
March 06-10, 2023 | Boston, MA

ABSTRACT BOOK

Seventh Edition of

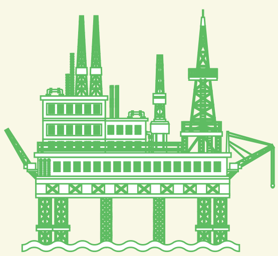
GLOBAL ENERGY MEET

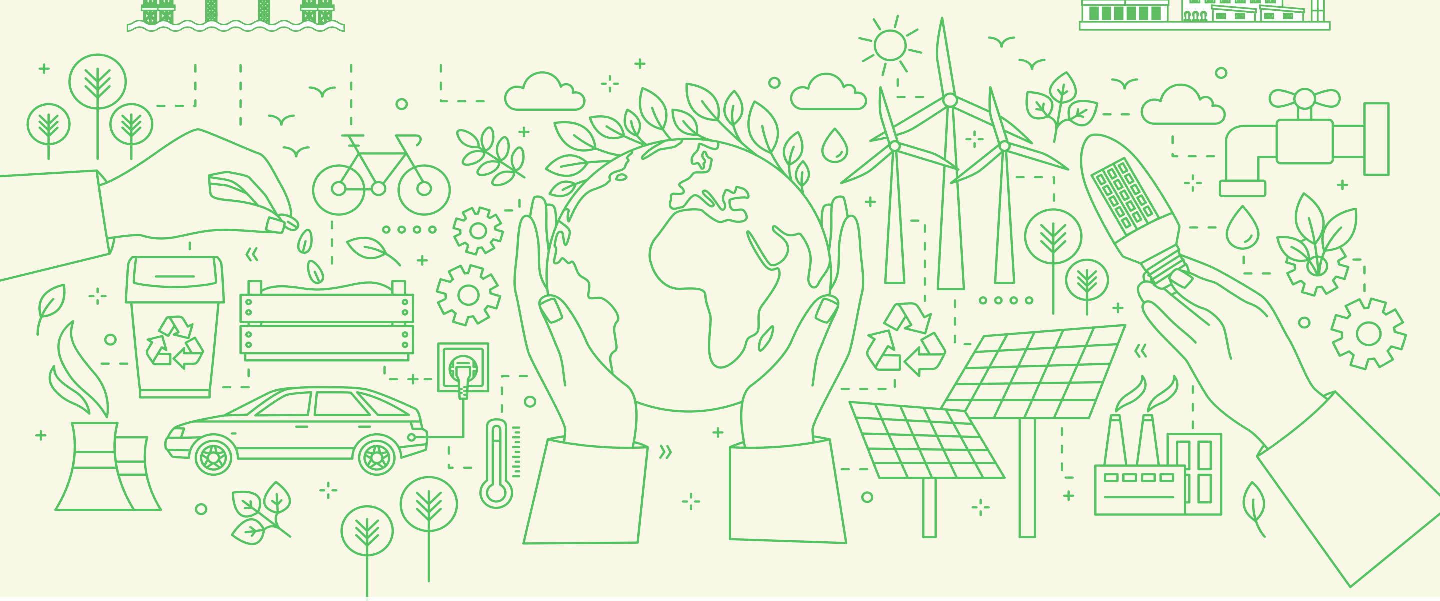
March 6-8, 2023 | Boston, MA

March 9-10, 2023 | Virtual (Eastern Time)

Sponsor

GIDARA ENERGY





Boston Marriott Newton Hotel
2345 Commonwealth Avenue, Newton, MA

gem@uniscigroup.net
www.globalenergymeet.com

Keynotes

Plasmon-Enhanced Photocatalysis and Photo-electrocatalysis for Renewable Fuel Generation

Nianqiang Wu

University of Massachusetts Amherst, Amherst, MA

Abstract

Photocatalysis and photo-electrocatalysis can be performed at mild conditions for generation of renewable fuel fuels such as hydrogen and ammonia. The energy conversion efficiency is currently limited by light absorption, charge separation and charge migration and other factors. This talk will demonstrate our effort on how to utilize surface plasmon resonance to enhance the energy conversion efficiency. This presentation will discuss the fundamental mechanisms of energy transfer from plasmon to catalysts. Also, this talk will demonstrate the design and applications of plasmonic photocatalysts and photo-electrocatalysts for enhanced generation of renewable fuel fuels.

Biography:

Dr. Nianqiang (Nick) Wu is Armstrong-Siadat Endowed Chair Professor in Materials Science in Department of Chemical Engineering at University of Massachusetts Amherst. He is Fellow of the Electrochemical Society (FECS), Royal Society of Chemistry (FRSC) and American Institute for Medical and Biological Engineering (AIMBE). He received several honors and awards such as Highly Cited Researcher (Clarivate Analytics, Thomson Reuters), ECS Sensor Division Outstanding Achievement Award and Benedum Distinguished Scholar Award. His research interest lies in (i) plasmonics and photonics, (ii) photocatalysts and photoelectrochemical cells, (iii) electrochemical energy storage, and (iv) biosensing and photodynamic therapy.

Recent Developments in Wind Energy

Christopher Niezrecki

University of Massachusetts Lowell, MA

Abstract

There has been a considerable growth in renewable energy installations in the last two decades. In particular wind energy is one technology that is leading the charge and has the potential to radically change how electricity is generated not only in the USA and globally. This presentation will review the technology and its impact on the nation's future energy portfolio. Recent advancements in wind energy will be presented and how wind energy can potentially be integrated with hydrogen along with opportunities and challenges.

Biography:

Christopher Niezrecki is a Distinguished University Professor of the Department of Mechanical Engineering at the University of Massachusetts Lowell. He is currently the Co-Director of the Structural Dynamics and Acoustic Systems Laboratory (http://sdasl.uml.edu/), and leads the Center for Renewable Wind Energy at UMass Lowell (www.uml.edu/windenergy). Dr. Niezrecki is also the Director of the NSF-Industry/University Cooperative Research Center for Wind Energy Science

Technology and Research (WindSTAR). Funding for his research ($20M+) has been provided through grants from numerous federal and state agencies as well as industry sponsors.

Scalable Low-carbon Hydrogen Production Technology Utilizing Waste/Process Heat

Kamiel Gabriel

Ontario Tech University, Canada

Abstract

Hydrogen production, storage, transportation, and energy conversion constitute the foundation of a hydrogen energy system. Hydrogen is a gas that generally does not exist naturally in a pure usable form. Conventional water electrolysis alone can't meet the growing demand for large scale production due to its limitations and the expanded electricity supply requirements to meet such demand. Thermochemical cycles like the copper-chlorine cycle developed at Ontario Tech University are promising alternatives for large scale hydrogen production. The Cu-Cl hydrogen process cycle generally involves four main steps: Hydrolysis, Thermolysis, Electrolysis, and Crystallization. The technology would displace considerable GHG emissions from conventional hydrogen produced via the steam methane reforming process. A key benefit of the Cu-Cl cycle is that all the chemical reactions occur within an internal closed loop and the chemical reagents and reactants are recycled on a continuous basis with zero GHG emissions.

The Cu-Cl cycle also has one of the lowest temperature requirements when compared to its peer thermochemical cycles. The process uses 9 kg of water for each 1 kg of hydrogen produces and produces 8 kg of oxygen. Instead of venting the oxygen to the atmosphere, it can be used to enhance the combustion process of host sites (e.g. cement or steel production facility), thereby reducing fuel consumption and GHG emissions further. In gaseous form, hydrogen requires some novel methods for transport and storage. In some applications, and under certain conditions, hydrogen's ability to weaken metal components through embrittlement poses a technical challenge.

Biography:

Gabriel holds a Bachelor of Science (honors degree), and a Master of Science degree in Mechanical Engineering from the University of Alexandria, Egypt, and a Ph.D. degree from the University of Manitoba, Canada. He holds a diploma in Space Science from the International Space University (Strasburg, France), and an M.B.A. from the Edwards School of Business.

Gabriel is an elected fellow of the Canadian Academy of Engineering (C.A.E.), a fellow of the Balsillie School of International Affairs (BSIA), and a Senior Fellow of the Institute for Science, Society and Policy (ISSP).

Is the Cellulosic-based Bio-economy Coming? Views of Researchers, Public, and Stakeholders

Ximing Cai*, Pan Yang and Qiankun Zhao

University of Illinois Urbana-Champaign, Urbana, IL

Abstract

The Renewable Fuel Standard (RFS), a U.S. federal program, has posed mandates on renewable fuel use; however, the mandates have been postponed due to a large gap between the actual advanced

biofuel production and the RFS targets. This can be attributed to a variety of factors, such as limited private investment and government assistance, technology setbacks, insufficient resource availability and infrastructure support, and the lack of coordination among multiple stakeholders. We proposed a stakeholder synergy approach to analyzing cellulosic biofuel development. This presentation will discuss the feasibility and barriers of cellulosic-based bio-economy in the U.S. Utilizing various data sources including survey results, social media posts, empirical and theoretical analyses, and model simulation outputs, we identified the preferences, barriers, and opportunities of multiple stakeholders such as producers, consumers, biorefineries, rural communities, government, and NGOs. The understanding of stakeholders' behaviors, resource constraints, and technology & policy status, were used to build an agent-based model (ABM) that simulates the complex interactions of multiple stakeholders under various resource constraints. The results of the ABM, used as a communication tool between researchers and stakeholders, show that the emergence of a cellulosic biofuel economy not only depends on resources, technologies, and demands, but also on the "synergies" of multiple stakeholders; the transition to a bio-economy will require coordinated efforts by policymakers, biorefineries, farmers, and consumers. To realize the transition, the challenges and research and policy innovation needs to promote cellulosic-based bio-economy will also be discussed, based on a synthesis of the various views of researchers, the public, and stakeholders

Electrochemical Energy Conversion and Storage

Lonnie G. Johnson

Johnson Research and Development Co., Inc., Atlanta, GA

Abstract

Johnson Research and Development (JRD) is a technology incubator company. The core technology underpinning two independent companies successfully spun off by JRD will be discussed: Johnson Energy Storage, Inc., and JTEC Energy, Inc: **JTEC Energy** is commercializing an entirely new engine invented by Johnson that is more efficient than existing engines. The engine converts heat directly into electricity and has no moving mechanical components and is suitable for both power generation and refrigeration. **Johnson Energy Storage (JES)** is developing the next two generations of disruptive rechargeable batteries. JES has achieved revolutionary breakthroughs in solid state technology using glass electrolyte separator. An overview of its lithium air battery research will also be presented. The presentation will also include a teaser on energy technologies currently being researched at JRD for future spin offs, particularly ambient water vapor condensation for potable water production and a revolutionary approach to solar energy conversion.

Biography:

Lonnie Johnson is president and founder of Johnson Research and Development Co., Inc., a technology development company, and its spin off companies, Excellatron Solid State, LLC; Johnson Electro-Mechanical Systems, LLC; and Johnson Real Estate Investments, LLC. He holds a B.S. degree in Mechanical Engineering, an M.S. degree in Nuclear Engineering, and an honorary Ph.D. in Science from Tuskegee University. In 1979, he left the Air Force to accept a position as Senior Systems Engineer at the NASA's Jet Propulsion Laboratory in Pasadena, California, where he worked on the Galileo mission to Jupiter. Returning to the Air Force in 1982, he served as an Advanced Space Systems Requirements Officer at Strategic Air Command (SAC) headquarters in Omaha, Nebraska, and as Chief of the Data Management Branch, SAC Test and Evaluation Squadron at Edwards Air Force Base in California. He was awarded the Air Force Achievement Medal and the Air Force Commendation Medal on two different occasions. In 1987, he returned to the Jet Propulsion Laboratory where he worked on the Mars Observer project and was the fault protection engineer during the early stages of the Cassini (Saturn) project. He was responsible for ensuring that single point spacecraft failures would not result in loss of the mission. During his nine-year career with JPL, he received multiple achievement awards from NASA for his work in spacecraft system design.

Renewable Energy

Solar Desalination Chimneys: Various Configurations and their Performance

Mahyar Abedi, Xu Tan, and Andre Benard*

Michigan State University, East Lansing, MI

Abstract

The integration of a solar chimney with a desalination system based on a direct-contact humidification/dehumidification approach can result in self-standing thermal systems with a variety of possible configurations. In the proposed systems, solar energy is used to create a hot air flow passing through a humidification and dehumidification unit. The integrated solar desalination chimneys uses solar irradiation to create buoyant air motion and can also power a small pump, thus resulting in no additional energy beyond solar. Data available in the literature for experimental solar chimney setups are examined to evaluate the potential of this novel desalination approach. A validated humidification-dehumidification model is used to investigate the performance of the desalination unit. The operation conditions for large, medium, and small scale systems are identified.

Biography:

Andre Benard is a professor of mechanical engineering at Michigan State University and his research interests are in the areas of multiphase flow systems, sustainable energy systems, heat transfer, turbulence modeling, and optimization.

Suitability Studies on Appropriate Waste to Energy Technologies for infectious Waste and e-waste in the Global South: A Philippine Case Study

Reynald Ferdinand Manegdeg[1, 4, 5], Analiza Rollon[2, 5], Florencio Ballesteros, Jr.[2, 5], Eduardo Magdaluyo, Jr.[3], Louernie De Sales-Papa[5*], Eligia Clemente[3, 5], Emma Macapinlac[2], Roderaid Ibañez[1], Rinlee Butch Cervera[3, 4] Dominador A. Eusebio[5] and David P. Lim[5]

[1]Department of Mechanical Engineering

[2]Department of Chemical Engineering

[3]Department of Mining, Metallurgical, and Materials Engineering

[4]Energy Engineering Program

[5]Environmental Engineering Program

College of Engineering, University of the Philippines Diliman, Quezon City, Philippines

Abstract

Seven waste to energy technologies were considered in this study including Anaerobic digestion, Conventional (Grate) Incineration, Fluidized Bed Incineration, Gasification, Conventional Pyrolysis, Plasma Pyrolysis and, Microwave-Induced Pyrolysis. The assessment process was carried out using a multi-attribute decision analysis method to select the appropriate infectious waste and e-waste in Metro Manila, Philippines. The attributes for the assessment includes overall efficiency, waste reduction rate, maximum capacity, reliability, lifespan, energy conversion cost, and environmental emissions. The initial screening from this process were then ranked according to efficiency, cost,

footprint, work ratio, emissions, and complexity. The study has demonstrated the feasibility of setting up a WTE plant for the treatment and disposal of residual wastes in Metropolitan Manila. The pyrolysis-Brayton plant was found to be the most suitable WtE plant for the identified residual waste. A significant advantage of this technology was its flexibility and small footprint to accommodate wastes from a multitude of geographically apart locations. Moreover, installing 1-3 tpd plants in clustered locations reduces significantly transportation costs.

Keywords: Waste-to-energy, Energy analysis, Multi-attribute decision analysis, infectious wastes, e-waste

Biography

de Sales' various specializations include Solid Waste and Night Soil Management, Water and Air quality monitoring and Hazardous Waste Characterization and Treatment. She headed and consulted on various projects in Toxic, Hazardous and Solid Waste Management, Water and Wastewater, Air Pollution and Management and Environmental Impact and Risk Assessment. She is the national expert for various endeavors for World Bank (Control of Contaminated Sites) and UNIDO (Non-Combustion Treatment Facility for POPs and Roadmap for Chemicals and Hazardous Waste Management). She is the Highest Award Recipient of UNEP Eco-Peace Leadership Center – World Environmental Forum in 2008. She is also a Mondialogo Engineering Awardee with Jury Distinction in 2005.

The Assessment on the Use of Domestic Electric Vehicles to Reduce Renewable Energy Variability

Christopher J. Sepka*

West Valley College, Saratoga, CA

Abstract:

This paper presents an analysis and model for the use of domestic electric vehicles (EVs) engaged in Vehicle-to-Grid (V2G) programs in order to provide stability to the grid network and phase out the on-demand use of Coal and Natural Gas for ramping purposes in the state of Texas. By analyzing public Texas energy data, it can be predicted that late parts of the afternoon or early evening would require the most intensive engagement of EVs while the earliest parts of the morning historically required the lowest participant due to the decreased demand in the consumption of power. The curve produced by the Real-Time Market (RTM) electricity pricing data supports this finding. Our results show that with a major percentage of registered vehicles in Texas becoming electric, there needs to be a substantial capacity of the battery allocated to the V2G program in order to remove the reliance on the most common hydrocarbons in the grid. Thus, it is imperative that additional energy storage systems are integrated into these networks in order to supplement existing car batteries and to ensure peak demand is satisfied.

Keywords: Vehicle-to-grid, Real-Time Market

Biography:

Christopher Sepka is a sophomore currently attending West Valley College in Saratoga, California. My major is Computing Engineering, and He presently pursuing my Bachelor of Science. He completed my first Research Undergrad Experience (REU) at Texas A&M University in Kingsville during the summer of 2022 on the **Assessment on the Use of Electric Vehicles to Reduce Renewable Energy Variability**. He will present my results at the conference and eventually share my analysis by publishing it in a scientific journal.

Scaling Perovskite and Organic Photovoltaics for Indoor Applications

Ardalan Armin* and Gregory Burwell

Swansea University, Singleton Campus, UK

Abstract

Photovoltaics (PV) based on next-generation semiconductors such as organics and perovskites are promising for indoor applications due to several attractive material properties: tailorable light absorption, low embodied energy and cost, structural conformality, and low material toxicity in the case of organics. Compared to their use in solar energy harvesting, indoor PV (IPV) devices operate at lower light intensities and thus demonstrate different area-scaling behaviour. In particular, the performance of large-area IPV devices is minimally affected by the sheet resistances of the transparent conductive electrodes (a critical limit at 1 Sun), but instead by factors such as their shunt resistance at low light intensities. Herein, the key parameters for improving the efficiency of large-area IPV using drift-diffusion and finite element modelling (FEM) and experiments are examined.

The scaling behaviour at low light intensities is theoretically and experimentally probed and demonstrated using the model organic and perovskite systems. These insights into IPV systems at varying light intensities provide insight into the required device characteristics for situation-targeted IPV optimization, including requirements for high shunt resistances for low-light performance. These new insights present a clear route toward realizing monolithic large-area organic photovoltaic cells for indoor applications – which is a necessary technical step to practical implementation.

Refs:

Burwell, Gregory, et al. "Scaling considerations for organic photovoltaics for indoor applications." Solar RRL (2022): 2200315.

Burwell, Gregory, et al. "Parameterization of Metallic Grids on Transparent Conductive Electrodes for the Scaling of Organic Solar Cells." Advanced Electronic Materials 7.6 (2021): 2100192.

Biography:

Ardalan Armin is an associate professor of Physics and Sêr Cymru Rising Star Fellow at the Department of Physics, Swansea University. He obtained his Ph.D. in Physics from the University of Queensland, Australia in 2014 and joined Swansea University in 2017. His current research and teaching activities focus on next-generation materials for optoelectronics and semiconductor device physics.

Sustainability Assessment of a Novel Solar Thermal Technology Applied to Industrial Processes

Valentina Stojceska*, Lisa Baindu Gobio-Thomas, Imaad Zafar, Hadi, Tannous and Savvas Tassou

Brunel University London, UK

Abstract

The environmental, economic and social impacts of a novel solar thermal system developed by EU-ASTEP project that could achieve a temperature of up to 400°C for industrial processes will be discussed. The system uses a novel Fresnel collector, SunDial, with a double tracking system

and Phase Change Material (PCM) storage, which allows the collector to operate in low and high irradiance locations. The results showed that there was a variation of the environmental, economic and social impacts of the newly developed technology as a result of the different components and amount of materials used for developing the new system. It was found that the manufacturing phase generated the highest environmental impact, followed by the transportation phase and then the waste disposal of the components at their end of life stage. The social aspect demonstrated some risk areas in the production of aluminium insert for the PCM storage tank and steel manufacturing for the collector. The carbon-dioxide emissions reductions for the potential application of the unit to the industrial processes were also calculated for the low and high irradiance locations. It was projected that for the future capacity of the high latitude Sundial is 1,828MWh, the GHG emissions reduction is 559 tonnes of CO_2 emissions while the future capacity of the low latitude Sundial of 2,157 MWh, the GHG emissions reduction is 909 tonnes of CO_2 emissions. This demonstrates the great potential of the new system to contribute to the decarbonization of industrial processes and meet the EU's 2050 environmental targets.

Iron and Vanadium-doping-induced Structural Phase Transition in Cobalt Diselenide Enabling Superior Oxygen/Hydrogen Electrocatalysis

Mabrook Saleh[1,2*], Prabhakarn Arunachalam[1], Abdullah M Al-Mayouf[1,2], and Haneen A. AlOraij[1]

[1]Electrochemical Sciences Research Chair (ESRC), Chemistry Department, College of Science, King Saud University, Riyadh 11451, Saudi Arabia

[2]K.A.CAR Energy Research and Innovation Center at Riyadh, King Saud University, Riyadh 11451, Saudi Arabia.

Abstract

TiO_2 is the first material discovered to demonstrate water splitting with, compared to many other semiconductors, high robustness against photo-corrosion and low environmental impact, chemical inertness, suitable band structure, and low cost. However, the main two drawbacks of TiO_2 are the fast recombination of photogenerated charges and the narrow absorption of the solar spectrum. The fast recombination of photogenerated e-h pairs in TiO_2 can be highly alleviated using vertically aligned TiO_2 nanotubes (TNTs) thus allowing faster charge transport and lower onset potential. This study aims to develop co-catalyst coatings that can help in stabilizing the TNTs photoelectrodes and preferably increases their light absorption and so the generated photocurrent. Here, we first examined the synergetic effect of Zr-doping and metal phosphate (MPi) such as (CoPi, NiPi, AgPi, Ni-Ag Pi) photoassisted electrochemical coating on the TNTs. We implemented a Zr coating strategy where Zr is involved in both bulk and surface modification of the TNTs. We also implemented a soft electrolytic synthesis deposition method that allowed a remarkable enhancement of both efficiency and stability of water oxidation kinetics in the TiO_2 nanotubes by the addition of a small amount of Zr precursor to the Fe precursor electrodeposition bath. Detailed optical and electrochemical investigation shows that in the optimized system (with Zr/Fe concentration of 3.5 mol%), the light absorption and e-h separation are both enhanced due to ~ 1 eV bandgap reduction and an order of magnitude high carrier concentration of the composite electrode compared to pure TNTs. The optimized Zr-doped α-Fe_2O_3/TNTs photoanode achieved a photocurrent density of 1.3 mA/cm^2 at 1.23 V vs RHE. Overall, this work might offer an innovative approach to fabricating and designing efficient electrodes with superior contact interfaces among photoanodes and numerous co-catalysts.

Biography:

Mabrook Saleh obtained his PhD (2020) from King Saud University (KSU) in the field of physical chemistry (electrochemistry). He currently works as a postdoc researcher at Electrochemical Sciences Research Chair (ESRC) at King Saud University. Mabrook has extensive experience with the fabrication of metal oxide semiconductor thin films and quantum dots materials by hydro/solvothermal, sol-gel, and dip-coating techniques. His current research mainly focuses in the design, chemical synthesis of new composite mesoporous materials, and processes in electro-chemical and solar fuel production. He published 38 papers in peer reviewed international journals, one US patent and three book chapters.

A Journey to High-efficiency, Low-cost Perovskite Solar Cells/Modules

Chun-Guey Wu

National Central University, Taiwan

Abstract

Organic-inorganic hybrid perovskite solar cell is one of the most promising new generation photovoltaic technology to achieve high efficiency with low process cost. A new two-step solution process to synthesis high quality perovskite film at room temperature was disclosed first. Combining with smooth PEDOTLPSS hole transport layer and high mobility electron transport ($PC_{61}BM$) layer, the planar heterojunction perovskite-$PC_{61}BM$ solar cell achieves the power conversion efficiency above 21%. This champion cell shows no current hysteresis both in voltage scan directions and rates. High quality, large-area perovskite film can also be made by one-step spin-coating and anti-solvent engineering its precursor solution with the assistance of free falling solvent extraction, followed by post-solvent treatment. The resulting perovskite solar module has high efficiency under both outdoor and indoor light as well as stable at high and low temperatures. The step-by-step for improving the quality of perovskite film to achieve high-efficiency, no current hysteresis, and stable perovskite solar cells and module will be presented.

Biography:

Chun-Guey Wu is the Professor and Dean of college of science, National Central University, Taiwan. His current research are focused on the investigation of the New Generation Light Driven Photovoltaic Cells, such as Dye-sensitized Solar Cells, Organic PhotoVoltaic devices and Perovskite Solar Cells, including the development of the new materials for every components (such as the charge transporting materials, absorber materials and electrodes) of the cells/modules and interface engineering.

Surgical Mining: An Effective, Efficient, and Environmentally Responsible Method to Unlock Essential Metals and Minerals

Jeronimo de Moura and Senior Mining Lead

Novamera, Canada

Abstract:

The clean energy transition, EV adoption and a growing population is fueling a rapid demand for metals and minerals, however experts are warning we'll be unable to meet our needs for decarbonization, with estimates predicting as much as a $12T gap in supply.

Mining companies are under enormous pressure to deliver, but face significant challenges including

decreasing ore grades, fewer new discoveries of deposits and increasing environmental and social regulations. Many of these issues are rooted in the ways in which we mine- relying on large scale deposits.

Novamera has developed a proprietary technology that enables 'surgical mining.' This transformative innovation has the potential to unlock more than $6T in small, narrow deposits globally that have previously been too complex or uneconomic to mine using conventional methods. The solution is a fraction of the cost and produces 95% less waste and 44% less GHG emissions- supporting the need for reserves while meeting aggressive ESG targets.

The technology uses machine vision, algorithms and AI to make conventional equipment 'smart,' able to precisely identify, navigate and extract high-value deposits including both base and energy transition metals (ie. Li, Zn,Ni, Co & Ag, Au).

Biography:

Jeronimo de Moura is one of Novamera's leading experts in Surgical Mining technology, being one of the holders of patents related to this technology. With extensive experience in the oil and gas industry combined with a Ph.D. in Drilling Engineering with an emphasis on innovative drilling technology applied to mining, Jeronimo has been involved in many multi-million Brazilian onshore oil and gas projects and led the Novamera Surgical Mining Technology proof of concept in 2021 in Canada. At Novamera Inc., Jeronimo also lends his vast experience in project management, design, cost control, KPIs, industrial maintenance, and production management to our mission.

Parallel Session - I

Renewable Energy

Design of Cryogenic Hydrogen Storage Tanks: Insulation Properties Predictions and Natural Convection Effects

Ram R. Ratnakar[1]*, Swapnil Sharma[2], Mahsa Taghavi[2] and Vemuri Balakotaiah[2]

[1]Shell International Exploration and Production Inc., Houston, TX

[2]University of Houston, TX

Abstract

The development of cost-effective and safe cryogenic storage of LH2 is an essential enabler for establishing global hydrogen supply chain. The existing storage technologies utilize vacuum-based insulation systems, which may lead to significantly high cost in maintaining vacuum and can cause potentially huge losses (including safety) upon failure. This necessitates the development of a storage technology that can utilize the non-vacuumed insulation systems. However, such development requires two key elements: (i) development of insulation property model that could predict the effective thermal conductivity of the targeted insulation materials filled with targeted gases in extended pressure and temperature ranges, and (ii) characterizing the natural convection effects of the gases filled in the interstitial spaces of insulation material. Note that the latter depends on the first and could (i) enhance the overall heat transfer through the insulation system leading to high boil-off rate, and (ii) create undesirable temperature patterns leading to cryopumping and integrity issues of the insulation system.

In this work, we present the detail review on insulation property modeling and investigate the natural convection effects due to unstable stratification of gas-density in porous insulation of large-scale storage tanks, especially towards impact on heat ingress, increase BOR rate, and temperature distributions within the insulation system. Finally, we summarize such effects and provide the detailed sensitivity analysis with respect to insulation properties and design parameters.

Keywords: Liquid hydrogen storage; Thermal properties; Cryogenics; Local property variation; Composite and porous materials, Heat transfer, Convective Loops.

Biography

Ram R. Ratnakar is a Subject Matter Expert (Thermodynamics/PVT) and a Sr. Researcher in R&D Mathematics & Computation at Shell Int. E&P. He is Editor-in-Chief of Upstream Oil & Gas Technology, Associate Editor of Frontiers in Fuels, Editorial Advisor of JNGSE and member of SPE's Advisory committees. He received B.Tech. from IIT Delhi, India and PhD from University of Houston, USA, both in chemical engineering. He has authored more than 50 technical papers and contributed significantly in the area of multi-scale modeling, reactive-transport, PVT and New Energy Technologies including Hydrogen, Geothermal and CCUS.

Breakthrough Zero-CO_2 Distributed Power Source

Randell Mills

Brilliant Light Power, Inc., Cranbury, NJ

Abstract

Brilliant Light Power, Inc. (BLP) has developed a new, zero-pollution, primary energy source based on a proprietary hydrogen plasma reaction that releases 200 times the energy of burning hydrogen that can be obtained from water. Our SunCell® having a capital cost of less than 1/10th that of solar was invented and engineered to harness this new source of power. Specifically, BLP is operating a SunCell® at commercial scale (250 kW) producing power levels that, upon finalization of engineering and design, can power essentially all power applications with no fuels or grid connection, projected $20/kW cap cost, $0.001 kW/h generation cost with no transmission, distribution, or demand charges, no supply chain issues, and zero pollution including CO_2. Our global and significant patent portfolio protects our leading technology position and products. The SunCell® comprises a plasma cell that injects hydrogen and catalyst, and two electromagnetic pumps serve as electrodes by injecting intersecting molten tin streams from corresponding reservoirs wherein the connected streams carry a low voltage, high current to form a Hydrino®-reaction plasma in a reaction chamber. The SunCell® is an optical power source having a dynamic-transparency plasma window. Optical power or radiation transfers power at 10 to 100 times the power per area compared to conduction and convection of combustion and nuclear power plants. The optical power source is mated with a commercial dense receiver array (DRA) comprising an ensemble of concentrator photovoltaics cells (CPV) that operate at 1000 times the light intensity of solar-farm PV cells to produce electrical power for total electrification of essentially all power loads.

Solving All the World's Energy Problems for Once and Forever

Peter J. Schubert

Indiana University-Purdue University Indianapolis, Indianapolis, IN

Abstract

The ultimate baseload power is that which can be delivered from orbit, especially if constructed from in situ materials. Power satellites can deliver GW-class power to municipal statistical areas and industrial parks using wireless power transfer from phased array antennae. Two recent innovations allow for a low cost per kWh, at maturity, along with a tiny carbon footprint. Remote from cities, local power and heat can be produced from non-food biomass. For villages and settlements in rural areas, agricultural residues can be converted to a tar-free hydrogen-rich syngas suitable for hydrogen extraction or as a fuel for an electrical generator (fuel cell or internal-combustion engine). This proven technology provides always-on power to off-grid locations, as well as heat for cooking or sterilization. Furthermore, with dry feedstock, the process generates biochar that can augment soil productivity, and be carbon-negative as well. Mineral ash from biomass conversion includes silica that can be reduced, with biochar, to produce metallurgical grade silicon. That silicon can be made porous with an chemical etch, and treated with a transition metal to produce a hydrogen storage medium. The parasitic energy loss of charging and discharging catalytically-modified porous silicon is very low, and it has negligible leakage. These qualities make for an ideal choice in fuel cell vehicles and portable electronics. Hydrogen can come from biomass in the countryside, or from powersat electrolysis during periods of low demand in the city. Taken together, these complementary technologies can power all of human needs for all time to come.

Biography:

Peter Schubert has 53 patents in the US and EU and 120 technical publications that span nine distinct technical fields. As the Director of the Richard G. Lugar Center for Renewable Energy, he has addressed technical and policy issues at the state and federal level, and internationally. He served as PI on grants from DOE, NSF, USDA, NASA and DoD, and was a Fulbright Specialist for the US Department of State. Professor Schubert is a licensed Professional Engineer. He is also the CEO of Green Fortress Engineering, Inc. working to commercialize renewable energy technology.

Technoeconomic Analysis of Hydrogen as Long-Term Energy Storage

Henning Hoene* and Xinfang Jin

University of Massachusetts, Lowell, MA

Abstract

The integration of the high shares of renewable energy into the grid raises significant technical challenges, such as weather dependence, variability, and uncertainty. These properties cause frequent and steep net load fluctuations and require great flexibility in the power system. Energy storage devices can provide services to help support the integration by aligning the balance between supply and demand, supplementing transmission, and providing operating reserves. In recent years, there has been an increased interest in using hydrogen as energy storage medium due to the desire to reduce greenhouse gas emissions by utilizing hydrogen for numerous applications. The use of hydrogen can be an effective method for storing large amounts of energy for long periods of time (e.g., days or weeks) either as a gas, liquid, or in the form of ammonia. In this study, we will perform a techno-economic analysis of energy storage cost for a 15MW wind turbine over 3-7 days. We will include cost from both hydrogen production and storage. Specifically, hydrogen will be produced from existing electrolyzers, including a proton exchange membrane electrolyzer, alkaline electrolyzer, and solid oxide electrolyzer. Hydrogen will be stored in compressed gas cylinders under high pressure. Hydrogen as energy storage will also be compared against the state-of-the-art Lithium-ion battery technology. The study aims to find the cost-effective energy storage application of hydrogen and identify the roles hydrogen could play together with Lithium-ion battery technique for a zero-emission energy future.

Biography:

Henning Hoene research interests include hydrogen production, redox flow battery, modeling and simulation of energy storage and conversion devices, and TEA analysis. He received his bachelor's and master's degrees in ME at University of Massachusetts Lowell (UML) in 2020 and 2021. As a PhD student at UML, he recently submitted a research paper to JES titled, "Parametric Study of a Bio-Inspired Non-Aqueous Redox Flow Battery Model". He also have been working on model development and validation for both fuel cells and electrolyzers using optimization algorithms. His goal is to create a projection study for renewable energy integration with hydrogen.

Public Perception of Green Hydrogen Technology and Infrastructure in Palawan and the National Capital Region of the Philippines

Alvin Garcia Palanca*, Dr. Rizalinda L. de Leon[1] , Cherry Lyn Velarde Chao[2] , and Bemboy Niño F. Subosa[3]

*[1,2,3]University of the Philippines Diliman, Philippines; *,[1,2] Energy Engineering Program, [1,3]Department of Chemical Engineering

Abstract

A residential consumer survey was conducted in the Philippines' National Capital Region (NCR) and two areas in the Palawan province (Puerto Princesa City and the Municipality of Narra), to determine awareness of the public on the use, risks and benefits, and their favorable or unfavorable perception of hydrogen, hydrogen infrastructure, and green hydrogen. We found a low level of awareness on hydrogen energy, hydrogen infrastructure, and hydrogen grid-size energy storage among the people in rural Narra and a relatively better knowledge of the same among those in the NCR. In contrast, we did not find much differences in perception of the risks and benefits of green hydrogen and hydrogen as a grid energy storage. Still, there is generally a positive public acceptance of hydrogen technology. There were, however, some concerns raised in the province of Palawan regarding water and land use and the environmental impact of green hydrogen. Basically, while people have a positive perception of hydrogen infrastructure, they are also quite cautious about the risks to public safety and the environment, whether these risks are outweighted by the benefits of adopting the technology. We could say that the favorable perception to hydrogen energy leans toward slightly less rational support in the Palawan areas compared to that in the National Capital Region.

Biography:

Rizalinda L. de Leon is professor of chemical engineering at the University of the Philippines Diliman. She heads the Fuels, Energy and Thermal Systems Laboratory at the UP Diliman Department of Chemical Engineering. She served as Dean of the UP Diliman College of Engineering from 2016 to 2019, Chair of the Department of Chemical Engineering (2010 – 2016), and prior to that as Energy Engineering Graduate Program Coordinator.

Performance Sensitivity of PEM Water Electrolyzers against Power Fluctuation, DI Water Utilization and Quality Variation

Majid Ali*, Xinfang Jin and Henning Hoene

University of Massachusetts Lowell, MA

Abstract

Green hydrogen is key to cleaning up American manufacturing and slashing emissions from the industrial sector, which accounts for a third of domestic carbon emissions, while creating good-paying jobs for American workers. Green hydrogen has also been recognized as a promising energy "buffering" solution to mitigate the intermittency and demand-supply mismatch issue facing the renewable industry. Using the state-of-the-art green hydrogen generation technology, proton exchange membrane (PEM) electrolyzer stack, this study will perform parametric analysis and sensitivity analysis of a 50Watt PEM electrolyzer stack using intermittent power sources. The PEM electrolyzer stack splits water into hydrogen and oxygen. The hydrogen produced through this process is then filtered, dehumidified and stored in a storage tank. The study aims to present the effect of various factors such as power fluctuation, deionized (DI) water quality and DI water utilization variation on the performance of PEM electrolyzer. Changing these parameters not only affect the production of hydrogen but also affect the durability of the electrolyzer. The change in DI water utilization will be achieved by using the DI water pump with a speed of 0-400 RPM and a flow range of 0-450mL/min. Among all these parameters, the most important parameter is DI water quality as it not only affects the production of hydrogen by the electrolyzer but also affects the durability of the PEM electrolyzer. It has been observed that using DI water with low resistivity may cause for the dramatic degradation of the PEM electrolyser.

Biography:

Majid Ali is a PhD student in the Mechanical Engineering Department at University of Massachusetts Lowell. He is currently working on the feasibility and resilience study of integrated hydrogen fuel cell systems. His research interest includes study and development of fuel cells systems, energy storages, modeling and simulation of thermo-fluid systems. Before being PhD student in August 2021, Majid was serving as a faculty member at Mehran University of Engineering & Technology (MUET) Shaheed Zulfiquar Ali Bhutto (SZAB) Campus Khairpur Mir's. He earned his MSc in Mechanical Engineering from University Teknologi PETRONAS where he worked on modelling & simulation of liquid desiccant dehumidification and air-conditioning system. Majid earned his Bachelor of Engineering (BE) degree in Mechanical Engineering from MUET, Jamshoro. He worked on the design and manufacturing of solar cooker project in final year of his BE degree.

Impact of Sulfonated Poly (Ether Ether Ketone) Pretreatments on Proton Exchange Membrane Fuel Cells Performances and Durability

Meriem Daoudi[1], Evelise Ferri[2,3], Claire Tougne[4], Assma El Kaddouri*[1], Jean-Christophe Perrin[1] , Jérôme Dillet[1] , Laurent Gonon[4] , Vincent Mareau[4] , Hakima Mendil-Jakani[4] , Veronique Dufaud-Niccolai [2], Eliane Espuche [3], Olivier Gain [3] and Olivier Lottin[1]

[1]Université de Lorraine, CNRS, LEMTA, 54000 Nancy/France

[2]Univ. Claude Bernard Lyon 1, CNRS, CP2M, 69001 Lyon/France

[3]Univ. Claude Bernard Lyon 1, CNRS, IMP, 69001 Lyon/France

[4]Univ. Grenoble Alpes, CEA, CNRS, Grenoble SyMMES, 38000 Grenoble/France

Abstract

Many works have been devoted to the development of low-cost ionomers as alternative to perfluorosulfonic acid membranes for proton exchange membrane fuel cells (FC) applications. Among them, sulfonated Poly(Ether Ether Ketone) (sPEEK) membranes. Before use, sPEEK membranes must be pretreated to ensure a complete protonic substitution and removal of residual reagents/solvent. This is generally ensured by soaking the membrane in an acid solution at room temperature or at 80°C [1]. In addition to that step, it was reported [2] that an hydrothermal treatment in water at high temperature for a few hours to a few days can improve the membrane nanostructure, water uptake and proton conductivity. Herein, we studied the impact of sPEEK membrane pretreatment on FC performances and durability using two different batches of Fumapem E730 from Fumatech, acquired in 2019 and in 2020. Five different protocols were tested. The first consists only in membrane acidification and rinsing, while the others also include a hydrothermal (*HT*) treatment in water at 80°C from 1 hour to 72 hours, and possibly an additional hydro alcoholic (*HA*) treatment. The 2020 batch membranes subjected to a *HA* pretreatment followed by a 72-hours *HT* pretreatment achieved the best performances – exceeding those of Nafion XL membrane - and the lowest high frequency resistance (Rhf) when tested in a FC. This could be explained by a better ionomer nano-structuration and therefore a better protonic conductivity. In addition, the impact of pretreatment is investigated via Accelerated Stress Tests (AST) to study their durability.

[1] JUN, M.-S., CHOI, Y.-W., KIM, J.-D. 2012. Solvent casting effects of sulfonated poly(ether ether ketone) for Polymer electrolyte membrane fuel cell. *Journal of Membrane Science*, 396, 32-37.

[2] MENDIL-JAKANI, H.; ZAMANILLO LÓPEZ, I.; MAREAU, V. H.; GONON, L. 2017. Optimization of hydrophilic/hydrophobic phase separation in sPEEK membranes by hydrothermal treatments. *Physical Chemistry Chemical Physics*, 19 (24), 16013-16022.

Biography:

Assma EL KADDOURI is currently associate professor at the LEMTA - Laboratoire d'Energétique et de Mécanique Théorique et Appliquée, Université de Lorraine since 2015. Assma does research in Electrochemistry and Mechanical Engineering. Their current project is the morphology, chemical structure, water properties of the membrane and membrane/electrode assemblies (MEA) and the link to performances degradation occurring during fuel operation. PhD in materials science, mechanics and electrochemistry from University of Grenoble (2014)

Fundamental Alkaline Membrane Fuel Cell Stack Optimization

J. V. C. Vargas[1]*, P. T. B. Polla[1], R. C. Raimundo[1], E. S. Watzko[2], L. S. Martins[1,3], W. Balmant[1] and J. C. Ordonez[4]

[1]Graduate Program in Materials Science Engineering (PIPE), and Sustainable Energy Research and Development Center (NPDEAS), Federal University of Parana (UFPR), 100 Cel. Francisco H. dos Santos Ave, Curitiba, 81531-980, Brazil

[2]Graduate Program in Energy and Sustainability (PPGES), Department of Energy and Sustainability, Federal University of Santa Catarina, Araranguá, Santa Catarina, 88905-120Brazil

[3]Department of Physics, Andrews University, Berrien Springs, Michigan 49104-0380, United States

[4]Department of Mechanical Engineering and Center for Advanced Power Systems, Florida State University, Tallahassee, Florida 32310-6046, USA Presenter Contact Details (Email: viriato@ufpr.br, +55 41 99705-0766)

Abstract:

This work introduces a dimensionless model computationally fast to predict the response of alkaline membrane fuel cell (AMFC) stacks according to the variations of the physical properties of materials and operating parameters. The model is based on electrochemical principles, conservation of mass, momentum, energy, and species. It also considers the pressure drops in the headers, gas channels of each unit cell and the temperature gradient with respect to the space in the flow direction. The simulation results include temperature distribution curves, efficiency, polarization, and power output curves. It was possible to observe the contribution of the anode and cathode potentials separately on the total power output of the AMFC stack, as well as the occurring power losses. This study optimizes numerically the relative sizes, spacing (internal structure), and aspect ratios (external configuration) of an alkaline membrane fuel cell stack for maximum net power output. Once the optimum configuration was found, a parametric analysis was carried out with respect to electrolyte concentration, stoichiometric ratios, and total volume of the fuel cell stack. The external optimal configuration of the AMFC fuel cell was found to be $\xi y/\xi x = \xi z/\xi x = 0.1$. The optimal electrolyte concentration was 40% KOH, and the maximum net power output was determined for constrained total stack volume. In other words, it was possible to find fundamental optima for maximum net power output for every tested volume constraint.

Biography:

Jose Viriato Coelho Vargas holds a PhD degree in Mechanical Engineering from Duke University (1994) and is a Full Professor at Federal University of Paraná, UFPR, Curitiba, Brazil, and a Visiting Professor at Florida State University. He leads the Energy and Thermal Sciences group at UFPR. His ongoing research involve the development of new fuel cells, new absorption refrigerators, thermal management of all electric ships, cabinets for electronic packaging, the use of infrared imaging in engineering and medicine, as well as the creation of a Sustainable Energy Research & Development Center (NPDEAS) from microalgae derived biodiesel and other sources.

Renewable Fuels Made in Maine from Maine's Woody Biomass

Hemant Pendse

Forest Bioproducts Research Institute (FBRI), University of Maine, Orono, ME USA

Abstract

Maine has significant quantities of unmerchantable low-grade woody biomass due in part to many pulp-mill closures and a very limited market for a few remaining biomass power plants to generate electricity. If the same woody biomass can be used to produce large amounts of high-value jet fuel and renewable diesel, the economic return to harvesters, processors, and the communities in which they live can be greatly enhanced with new jobs in this sector. UMaine's Forest Bio-products Research Institute (FBRI) has developed processes to produce jet fuel from woody biomass grown in Maine. Our wood to jet fuel project is based on FBRI's patented thermal deoxygenation process, which yields jet fuel that meets key specifications for Sustainable Aviation Fuel (SAF). We operate two pilot plants. The Biomass to Bioproducts Pilot Plant (B2P2) is designed to convert one dry metric ton of biomass into organic acids and biochar. The intermediate process containing mixed organic acids is then converted to synthetic crude oil in the Synthetic Crude Oil Pilot Plant (SynCOPP) at a crude oil production rate of about 60 kg/day. The conversion technologies have been tested in several 100-hour continuous operation campaigns. This presentation tells the story of discovery, innovation, and the proof of concept at commercially relevant scale. Plans for demonstrating the technology at a small commercial facility in Maine are underway.

Biography:

Pendse is the Founding Director of the Forest Bioproducts Research Institute (FBRI) which was established in March 2010. Dr. Pendse led establishment of a new Technology Research Center (TRC) for floor-scale processing at a 40,000 sq. ft. high-bay facility in Old Town, which has been in continuous operation since June 2012. Since 2011 he has led the "Wood to Jet Fuel" program. As an internationally recognized leader in forest bioproducts, Pendse was named the University of Maine's 2021 Distinguished Maine Professor by the UMaine Alumni Association. Under Pendse's leadership, FBRI received $22 million for Wood to Liquid Fuels projects.

Current State of Alternative Fuels in Private Transportation

Tamas Mizik

Corvinus University of Budapest, Hungary

Abstract

Humanity must face several problems and global warming is one of the most challenging ones. It is caused by greenhouse gas emissions. The major emitters of these gases are industry; agriculture, forestry, and other land use; and electricity and heat production, while transportation sector comes 4^{th}; however, its emission increases rapidly. Its primary reason is the increasing size of the global vehicle fleet, especially in China and India.

The fossil energy resources of the Earth are finite; therefore, humanity must find alternative, renewable solutions in every sector. These options are called alternative fuels in transportation sector. As fossil energy resources are limited, alternative fuels are becoming more important. This research aims to provide a comprehensive analysis of five different fuel alternatives, i.e. ethanol and biodiesel (biofuels); electricity, biogas, and green hydrogen, by comparing them to their fossil competitor.

Biography:

Tamas Mizik holds a PhD in Business and Management and MSc in Business Administration from Corvinus University of Budapest. He has been participated in various EU funded projects. He is an active member of a currently running EU Horizon2020 research project on the connections between sustainable development goals and international trade led by Corvinus University of Budapest. He worked for various international and governmental bodies including FAO, World Bank, DG Agri, Croatian and Hungarian government as an expert/advisor. His major research interests are biofuels, international agri-food trade, and agricultural policies.

Biodiesel Production from Flue Gas and Domestic Wastewater: Waste Beneficiation by Desmodesmus multivariabilis Mixotrophic Phycovalorization

Hendrik G. Brink* and Frederick V. Lubbe

University of Pretoria, South Africa

Abstract

Combustion flue gas and domestic wastewater are priority anthropogenic waste streams due to their ubiquity and significant environmental impact. Valorization of these streams to valuable energy and chemical products is gaining momentum; microalgal biodiesel is classified as a third-generation biofuel.

The current study assessed the feasibility of integrating flue gas and low-carbon domestic wastewater as substrates to produce microalgal biodiesel using an indigenous strain of microalgae (*D. multivariabilis*). This involved assessing the effect of CO_2 supplementation on biomass yield, the FAME (fatty acid methyl ester) yield, and the final effluent water quality.

The microalgae were grown in batch experiments where low-carbon wastewater was supplemented with two different blends of synthetic flue gas resulting in CO_2 concentrations of 5% and 2.5% CO_2, and atmospheric air as baseline (0.0% added CO_2). The growth rate and biomass yield were found to increase linearly with increasing CO_2 concentrations, which indicated a dependence on the autotrophic metabolism of the microalgae. The FAME yield and production were found to correlate strongly with mixotrophic metabolism, and had an optimal point at 2.5% CO2, with a maximum FAME yield of 193 mg/mg dry biomass. The removal of nitrogen in the media exceeded 89% for all scenarios.

From the results of the study, it can be deduced that not only is it feasible to grow *D. multivariabilis* on a combination of flue gas and wastewater, but that the optimal FAME yields were found to occur because of such a combination.

Biography:

Hendrik Brink (PhD, PrEng) completed his PhD (Chemical Engineering) in 2015, specializing in Bioreaction Engineering. He has been appointed as Associate Professor, since January 2022, in the Department of Chemical Engineering at the University of Pretoria. During his tenure he has published 65 papers, has been cited 280 times, and currently has an H-index of 9. He has successfully supervised/co-supervised 14 master's degree candidates and 1 PhD candidate, and currently supervises/co-supervises 8 Master's degree and four PhD candidates. He has attended 22 national and international academic conferences. His research mainly focuses on waste valorization towards a circular economy.

Ethanol Production by Clostridium sp. using Solid-state Syngas Fermentation in Micro-porous Matrix

Teresa Matoso M. Victor (Teresa M. Ndlovu) [1,2*], Zhiyong Zheng[3] and Alan C. Ward[4]

[1]ISPTEC, Instituto Superior Politécnico de Tecnologia e Ciências, Av. Luanda Sul, Rua Lateral Via S10, Talatona, Luanda-Angola

[2]School of Chemical Engineering and Advanced Materials Newcastle University, Newcastle upon Tyne NE1 7RU (UK)

[3]Key Laboratory of Industrial Biotechnology Ministry of Education, Jiangnan University, Wuxi 214122, China

[4]School of Biology Newcastle University, Newcastle upon Tyne NE1 7RU (UK)

Abstract:

Bioethanol is predominantly produced through the fermentation of easily degradable carbohydrate substrates, such as corn starch and sugar cane. Alternatively, fermentable sugars can be obtained through the acid or enzymatic pretreatment of insoluble cellulosic biomass. However, most of the biomass sources, like straw and wood cannot be converted to ethanol by microorganisms. Gasification of organic biomass to produced synthesis gas as a feed stock for the synthesis of ethanol and other valuable compounds is possible. This pathway takes advantage of microorganisms with the ability to metabolically convert CO and H2 in syngas to ethanol or acetic acid depending on the conditions of their environment. This project aimsto enhance the ethanol production through fermentation process, to overcome the limitations underlined, process intensification will be applied using an inert and hydrophilic micro-porous matrix, with higher rate of nutrient diffusion. strict autotrophic bacterium, Clostridium ljungdahlii, will be cultured with syngas medium, immobilised as solid-state fermentation process; to improve gas mass transfer rate and the process performance. Process Intensification aims to reduce the reactor volume by 10-fold or more and is achieved by the superimposition of two or more processing fields. Bioprocess Intensification can therefore be achieved through the reduction of the diffusion path for the reactants and products and through the creation of the optimum physico-chemical environment for cell growth and to elicit expression of biosynthesis. Increasing the yield, decreasing production volume and labour are all important in making biological production of natural product more attractive and consequently energy cost reduction.

Biography:

Teresa Matoso M. Victor graduated with Honours Degree in Chemistry with Chemical Engineering from the University of Northumbria, UK in 2001. From 2003 to 2004, She completed Master's Degree in Sustainable Chemical Engineering at the University of Newcastle Upon Tyne, UK. In 2009, at the same institution, She concluded doctorate in Chemical Engineering, research took place between 2005 to 2008, She was involved with project in intensification of antibiotics production by Streptomyces coelicolor A3 (2), using micro-porous polymers. Multidisciplinary project involved Chemical Engineering, Chemistry, Polymerization, Materials Sciences, Molecular Biological, Microbiology and Bioinformatics.

Techno-economic Analysis of Biogas Conversion to Liquid Hydrocarbon Fuels through Production of Lean-hydrogen Syngas

Moti Herskowitz* and Tomy Hos

Ben-Gurion University of the Negev, Israel

Abstract

Large-scale biogas plants are a viable source of CH4 and CO2 to be converted efficiently into

high-value products. Specifically, production of liquid hydrocarbons can enhance availability of green fuels while achieving significant CO2 reductions on site. In this study, production of liquid hydrocarbons is simulated by dry reforming of biogas into lean-hydrogen syngas, further converted in CO hydrogenation and oligomerization reactors. The process was modeled by using CHEMCAD based on published experimental results with the projected feed composition. High molar feed ratio of CO2/CH4 (>1.7) was set for the reformer to minimize steam requirement while avoiding carbon formation and reaching optimal H2 to CO molar ratio (0.7). Two options were techno-economically evaluated based on a biogas plant with capacity of 5000 Nm3 /h that produces between 13.8-15.7 million liters per year of blending stock for transportation fuels. The economics of the process depends mainly on the cost and availability of the biogas. The minimum selling price of the liquid fuels is 1.47$/liter and 1.37$/liter for options 1 (once-through conversion of syngas to liquid fuels) and 2 (recycle of tail gas from oligomerization reactor), respectively, and can be significantly reduced in case the biogas throughput is increased to >20000 Nm3 /h. Recycling of the tail gas (option 2) yielded higher productivity, resulting in higher carbon yield (77.9% on the basis of methane) and energy efficiency (67.1%).

Biography:

Moti Herskowitz is professor of chemical engineering and researcher in the fields of advanced materials, heterogeneous catalysis, and reaction engineering and renewable fuels. He served, among other positions, as VicePresident for R&D at the Ben-Gurion University from 2003 to 2014. Moti established the Blechner Center for Industrial Catalysis and Process Development in 1995 and has led scientific and technology programs (http://in.bgu.ac.il/en/indcat/Pages/default.aspx). Moti has published over 160 papers and 27 patents based on basic and applied research, related to advanced catalytic materials, processes and their application in the production of novel renewable fuels and chemicals.

Valorization of Biogas for Market Development and Remission of “Environmental Nuisance” in Uganda

Irene Namugenyi[1,2,*] and Joachim Scholderer[1]

[1]Norwegian University of Life Sciences, School of Economics and Business, Chr. Magnus Falsens Vei 18, NO-1433 Ås, Norway

[2]Makerere University, Makerere University Business School, Plot 21 A, Port Bell Rd, Kampala, Uganda

Abstract:

In Uganda, biogas is a low-value product considered a pro-poor renewable energy source. Farmers with excess biogas release it into the atmosphere contributing to global warming. This study used mixed data sources and methods to explore how biogas can be valorised to stand a chance as a commercial market offering and reduce greenhouse gas emissions. The results reveal that the biogas produced in Uganda does not meet the desired 98% methane quality to stand a chance as a commercial market offering; the pilot production process never got close to even the lower specification level of 95% for upgraded methane (CH_4) and the upper specification level of 5% for carbon dioxide (CO_2). The study also found that small-scale biogas producers with excess gas have a high desire to sell it but have no idea of how to valorize it to reach the market. Thus, they end up releasing these greenhouse gases. Furthermore, clear clustering of the product category, bioelectricity/biogas, reveals three promising customer segments: bioenergy entrepreneurs, gas companies and electricity suppliers. These results imply that to become a commercial market offering, the quality of biogas needs to be improved using valorisation strategies like monitoring gas quality, shaping the market, market research and certification and controls. The bioenergy

policy could consider subsidizing valorisation technologies to make them affordable for farmers and thus support a more climate-smart biogas business development.

Biography:

Irene Namugenyi holds a BSc. Degree in Entrepreneurship and Small Business Management and an MSc. in Procurement and Supply Chain Management obtained in 2010 and 2013 from Makerere University respectively. Irene is a lecturer at Makerere University Business School (MUBS) in Uganda. She is a PhD fellow researching Market Development for a sustainable transition to bioenergy in Uganda. Her thesis investigates how developing countries can use market development policies to scale up sustainable energy transitions.

Enhancement of Syngas Production in Co-pyro-gasification of Biomass and Plastic Waste Materials: Computational Study

Darkwa[1]* J, Kwawu[2] C, Adei[2] E, Agyekum[2] K, Boateng[2] I D and Kemausor[3] F.

[1]University of Nottingham, Nottingham, NG7 2RD, UK;

[2]Department of Chemistry, Kwame Nkrumah University of Science and Technology, Ghana;

[3]College of Engineering, Kwame Nkrumah University of Science and Technology, Ghana

Abstract:

The process of co-pyro-gasification of biomass and plastics appears to have the potential for increasing syngas production for power generation and thus minimizing the impact of plastic waste on the environment. This study was based on co-pyro-gasification of selected natural/synthetic polymers and cocoa pod husks as biomass material to ascertain the optimal ratios for enhanced volatile yields. The results showed that gasification of pure biomass commenced at 1500 K, whereas gasification of mixed plastics and biomass started at a much lower temperature of 1000 K accompanied with higher syngas yield. Single and multiple plastics produced the most syngas while double plastics had detrimental impact on syngas production. For instance, single plastics with polyethylene terephthalate achieved 65% increase in syngas yield. Mixed-plastics consisting of high-density polyethylene, low-density polyethylene, polypropylene, and polyethylene terephthalate, achieved an increase of 40% - 55% in syngas yield. Whereas antagonistic effects were observed in some double plastics systems such as polyethylene terephthalate and polypropylene. The results indicate that although plastics are instrumental in the thermodynamic equilibrium yields of syngas, the type of plastics and their groupings do also have a significant effect on the yields. Experimental study is strongly recommended to validate the feed proportions for high syngas production.

Biography:

Professor Jo Darkwa is a professor of Energy Storage Technologies at the University of Nottingham, UK. He is also Editorial Board Member of Energy Storage Journal and an Associate Editor of International Journal of Low Carbon Technologies. He was the founding Director of the Centre for Sustainable Energy Technologies (CSET) and Director of Key Laboratory for Integrated Thermal Energy Storage Technologies (ITEST) at the University of Nottingham, China. He has researched and published widely in phase change materials (PCM) and thermochemical energy storage systems. He has in the past organized several International Conferences/Symposia and given keynote addresses in energy-related topics.

Initiatives and Development Toward the Realization of Carbon Neutral Society using New Solid Bioenergy Technology

Tamio Ida* and Supitchaya Cherdkeattikul*

Kndai university, Bio-coke Research Institute, Japan

Abstract:

At the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) in December 2015, the Paris Agreement was adopted as a new international framework for reducing greenhouse gas emissions after 2020. The world has taken a major turn toward this observance. To comply with the Paris agreement, it is necessary to technologically develop the foundations of social infrastructure with new energy creation from new technological development for the targets listed in SDGs Goal 7. In thispresentation, we will explain the development trends of biocoke, a new biosolidification technology that can be formed from all biomass resources on the earth. For casting, by partially expending (or substituting) the fuel in the cupola with biocoke made from a variety of different substances, we found the characteristics of operating cupolas and the difference in the maximum substitutional rate for foundry coke related to the substances of biocoke. Especially, we have verified that the cupola operation can be operated without problems up to a conditional maximum of 20 mass% substituting of coke for the same calorific value. For the steel industry, we suggest the possibility of introducing carbon-neutral renewable energy in steelmaking based on the results of the first CO2 reduction large trial test in an electric arc furnace using biocoke technology. In current issues, about 52% of the input energy is lost in arc furnaces, of which about 36% is lost as waste gas heat.

Biography:

Tamio Ida is a director/professor of Bio-coke research institute at Kindai University. I like studying for renewable and sustainable energy based on development of new solid bioenergy technology. This new technology has a lot of interesting to various direction. Especially, a biocoke technology has high density and strong compressive strength, high binding force between bio-particles as alone technology. This technology can be replacement from coal coke to biocoke on steel industry in possible without energy scramble.

Advances in Energy Hybridization for Resilient Supply: A Sustainable Approach to Meet the Growing Demand in Developing Countries

Joseph D. Smith[1]*, Haider Al-Rubaye[1], Mohammed H. S. Zangana[2] , Yishu Zhou [3] , and Greg Gelles [3]

[1]Missouri Univ of Sci and Tech, USA

[2]Natural Gas Processing & Multiphase Flow, Koya Univ, Iraq

[3]Economics, Missouri Univ of Sci and Tech, USA

Abstract:

Energy poverty, defined as a lack of access to reliable electricity and reliance on traditional biomass resources for cooking affects over a billion people every day [1]. The World Health Organization estimates household air pollution from inefficient stoves causes more premature deaths than malaria, tuberculosis and HIV/AIDS) [1]. Increasing demand for energy has led to dramatic increases in carbon emissions. The need for reliable electricity and our need to limit carbon emissions drives research on Resilient Energy Systems that provide low-carbon energy through combined wind,

solar, and biomass energy with traditional fossil energy that increase production efficiency and reliability while reducing generating costs and carbon emissions [2]. Microgrids have been designed and implemented around the world [3] with a few focused on environmental impacts [4,5] but most focused on the technical challenges of designing, implementing and applying microgrids [6]. A cradle-to-grave life cycle assessment (LCA) has been used to assess the environmental and economic performance of resilient energy systems operated under diverse conditions to evaluate reliable operation. A sample resilient energy system has been developed and used to optimize control strategy prior to implementation in rural applications. The system is designed to provide reliable electricity for heating, cooking, lighting and pumping clean water. The technical challenges related to resilent energy systems in developing countries is the subject for this paper.

1. Tanaka, N., Kjorven, O., Yumkella, K.K. “Energy Poverty; How to make modern energy access universal?” Special early excerpt of the World Energy Outlook 2010 for the UN General Assembly on the Millennium Development Goals (2010). 2. Fikru, M.G., Gelles G., Ichim A., Kimball J., Smith J., Zawodniok, M.J. “An Economic Model for Residential Energy Consumption, Generation and Reliance on Cleaner Energy in Missouri Energy Consumption, Generation and Reliance on Cleaner Energy in Missouri,” Renewable Energy, 119, 429-438 (2018). 3. Mahapatra S., Dasappa S, “Rural electrification: optimizing the choice between decentralized renewable energy sources and grid extension,” Energy Sustain Dev, pp. 146–154 (2012). 4. Del Rio, P., Burguillo, M., “An empirical analysis of renewable energy deployment on local sustainability,” Renew Sustain Energy Rev, 13, pp. 1314–1325 (2009). 5. Nagrapurkar, P., Smith, J. “Techno-economic optimization and social costs assessment of microgrid-conventional grid integration using genetic algorithm and Artificial Neural Networks: A case study for two US cities,” Journal of Cleaner Production, 229, 552-569 (2019). 6. Lasseter, R.H., Paigi, P., “Microgrid: a conceptual solution,” IEEE 35th Annual Power Electronics Specialists Conference, PESC 04, pp. 4285–4290 (2004).

Biography:

Joseph D. Smith has completed his PhD from Brigham Young University, Provo, Utah, USA. He is the Wayne and Gayle Laufer Endowed Energy Chair, in the Department of Chemical and Biochemical Engineering. He has published more than 70 papers in high impact journals and serves as a member of the editorial board for several journals including Applied Energy, Biofuels, and AIChE Journal. Dr. Smith serves as Chief Technology Officer for Elevated Analytics aimed at developing advanced sensor systems for industrial gas flares and landfills.

Design Sustainable Catalysts for Converting Lignin into Liquid Oil Guided by Inverse Molecular Design Theory

Dequan Xiao

University of New Haven, West Haven, CT

Abstract:

Inverse molecular design approaches based on quantum chemistry have emerged as an intelligent computational approach for materials discovery. In this presentation, I will apply the inverse molecular design theory for the experimental design of sustainable catalyst for converting lignin to liquid oil. The approach of inverse molecular design theory aims at searching for optimum points on the hypersurfaces defining the property-structure relationships in catalysis, and then mapping out the catalytic structures at the optimum points, leading to enhanced efficiency and success rate for catalyst discovery. The design catalyst was verified by catalyst synthesis and characterization and reaction analysis, showing significantly enhanced catalytic activity than the reference catalyst. Our results indicate that the inverse molecular design approach can provide promising catalytic

solutions on producing sustainable fine chemicals from natural or man-made waste polymers.

Biography:

Dequan Xiao earned his PhD degree in theoretical and computational chemistry from Duke University and completed his postdoctoral work at Yale University from 2009 to 2013. At University of New Haven, he is the Buckman Chair associate professor and the director of Center for Integrative Materials Discovery. His research interests focus on developing new theoretical and computational chemistry methods to drive the experimental discovery of novel chemicals such as sustainable catalysts, molecular drugs, and polymer complexes. He published 106 peer-reviewed articles and reviews in high-profile journals and obtained 4 patents.

Life Cycle Assessment and Cost of Biogas Production from Cannabidiol Hemp Residues

Alana Smith[1]*, Nelson Granda Marulanda[2], Lindsey McGregor[2] and Jasmina Burek[1]

[1]*University of Massachusetts Lowell, United States*

[2]*Western Carolina University, United States*

Abstract:

Since the legalization of industrial hemp farming, the hemp plant has been grown for its seeds, fibers, and oils. Although the plant itself may be considered sustainable for its potential to be a carbon sink, Cannabidiol (CBD) production processes currently follow a linear process model, using the take-make-waste philosophy. In the production phase, about 80% of hemp feedstock is left as residual waste. There is a potential to use this low-cost lignocellulosic residual hemp waste as a feedstock for biofuel production. The global CBD market is projected to reach 44 billion USD with a compound annual growth rate of 27.8% from 2022 to 2029. This calls for a techno-economic (TEA) evaluation and life cycle assessment (LCA) of the existing and alternative biofuel system. The goal of this research is to investigate the utilization of hemp crop-residue as a biogas and explore the potential for creating circularity in the CBD industry to enhance environmental quality, social equity, and economic prosperity. An anaerobic biodigester is proposed to transform the residual hemp into biomethane which can be used to replace or supplement an existing fuel in a heating element in the CBD production process. An experimental biodigester is used and biogas results are compared to a process model. A comparative LCA is conducted for the baseline scenarios including hemp residuals to waste scenarios (e.g., composting, incineration, and landfill) and for hemp residuals to biomethane scenario (waste-to-energy) produced in a biodigester, which replaces fossil fuel used in CBD production.

Biography:

Alana Smith is a first-year PhD student at the University of Massachusetts Lowell studying Mechanical Engineering and researcher in the BUilding REsilience through Knowledge (BUREK) Lab. Her research is focused on resilient systems in the renewable energy and agri-food sector. Using life cycle assessment, techno-economic analysis, and process modeling, Alana is working on finding environmentally, socially, and economically sustainable solutions to energy and food security problems facing the world today. She uses handprint methodology to measure the effectiveness of positive changes to the business-as-usual case and encourage positive change in individuals, communities, and organizations.

Upstate New York Wind Farm Black Start Towards 70% Renewable Penetration Goal

Christian J Lyken, Dan Lu, Junpeng Zhan and Xingwu Wang*

Alfred University, Alfred, NY

Abstract

Wind energy harvesting is a critical issue for power grid systems since wind speeds vary continuously. Our ultimate goal is to collect instantaneous wind data for electrical power generations and grid load managements in order to achieve renewable penetration goals. In New York State (NYS), the renewable energy penetration will be 70% by 2030. The ambitious plans challenge us to innovate resilient and reliable power grid systems. Among all renewable sources in NYS, the wind energy source is being developed most. For power grid systems, we have to consider the regular system operations with black start using wind sources. In this paper, different grid configurations are explored via OPAL-RT platform. The results of such renewable power utilization can be utilized to achieve upstate New York wind farm black start.

Biography:

Xingwu Wang is a Professor of Electrical Engineering at Alfred University. He has published more than 100 papers, along with 45 US patents. Recently, he co-authored following papers: "Impacts on human development index due to combinations of renewables and ICTs--new evidence from 26 countries (Renewable Energy, May 2022)" and "Can Mobile Information Communication Technologies (ICTs) Promote the Development of Renewables? -Evidence from Seven Countries (Energy Policy, November 2021)."

Feasibility of Land-Based Wind Generated Electricity for the US Southeast

Sri Sritharan[1]*, Bin Cai[1] and Paul Gayes[2]

[1]Iowa State University, Ames, IA,

[2]Coastal Carolina University, Conway, SC

Abstract:

In recent years, it has been realized that tall towers can increase land-based wind energy, especially in the US Southeast. This presentation uses measured and simulated wind resources at 80 m and above from multiple locations in South Carolina to demonstrate that 100-160 m tall wind turbines would enable sustainable land-based wind energy generation in the Southeast. By combining tall towers and today's turbine technologies, wind power can be generated with a net capacity factor in the 35-40%. Future turbine and blade technologies are expected to lead to specific power below 200. With such low specific power, tall land-based wind farms can be designed in this region to achieve a net capacity factor exceeding 40%.

Biography:

Sritharan is an Anson Marston Distinguished Professor of engineering at Iowa State University. His expertise includes: 1) wind energy/wind engineering; 2) structural design; and 3) precast concrete structure systems. A fellow of the American Concrete Institute (ACI), Sri has published over 250 journal and conference papers and received numerous awards and recognition for his research and outreach activities. He is the developer of the Hexcrete technology that can be used to build tall wind turbine towers.

The Future of Long-distance Transportation: Recyclable, Sustainable, and Clean Solar Metal Fuels

Youssef Berro[1]*, Marianne Balat-Pichelin[1], Fabien Halter[2], Samuel Jeanjean[2], Christian Chauveau[2], Jean-François Brilhac[3], Adeline Andrieu[3] and Clément Dumand[4]

[1]PROMES-CNRS UPR 8521, France

[2]ICARE-CNRS UPR 3021, France

[3]LGRE-UHA EA 2334, France

[4]STELLANTIS Group, France

Abstract:

The use of metal powders as combustion fuels started since the 1970s in the aerospace field as for Mars missions. Their use for future long-distance transportation becomes attractive when they are regenerated using renewable energy sources through combustion/reduction cycles. This motivates the creation of the STELLAR project, funded by the ANR, as a collaboration between ICARE, LGRE, PROMES laboratories and Stellantis group aiming for the production of clean sustainable solar metal fuels. We proved that aluminum is reactive as classical hydrocarbon fuels, with similar specific energies and burning velocities, when stabilizing an Al-air flame in a Bunsen burner. Gas-phase and condensed-phase temperatures evaluation allows performing a global energy balance of the system, thus showing a power output of the system of about 3 kW. Similarly, magnesium particles were burned in a swirledstabilized Mg-air flame in an innovative power generation system allowing to recover 80% percent of the power released by the combustion (up to 11 kW). The mass trapping efficiency of the produced submicron magnesia exhibited an average of 98%. Furthermore, for a global equivalence ratio of Mg/air close to 1, the NOx emissions were below the minimal NOx amount emitted by a gasoline engine. The sustainable regeneration of those metal fuels was performed through the carbothermal reduction of metal oxides using concentrated solar power. Experiments were performed in the Sol@rmet reactor placed at the focus of a 1.5 kW solar furnace allowing to regenerate high-purity metal powders with yields up to 95% for Mg and 77% for Al.

Biography:

Youssef Berro obtained his master degree in petrochemical engineering from the Lebanese University (Lebanon) in 2016. In 2019, he obtained his double-degree Ph.D. from the Lebanese University (Lebanon) and Lorraine University (France) by studying the biomass pyrolysis and the hydrodeoxygenation of bio-oils to produce oxygen-free aromatic fuels. Nowadays, his research as a postdoc fellow at PROMES-CNRS laboratory, under the ANR STELLAR project, consists on the sustainable production of clean metal fuels using concentrated solar power (CSP) at the solar furnace of Odeillo (France).

Novel Materials for Cost Reduction and Extended Service Life on Wind Off-shore Facilities

Anna Wojdyla-Cieslak*, Alan Taylor, Tamoor Masood and Ana Antelava

TWI Ltd, United Kingdom

Abstract:

The next generation of large offshore wind energy generators and tidal power generators needs improvements to solve challenges related to materials, coatings and multi-material architectures to increase operational performance and allow an appreciable reduction of the overall cost: capital expenditure, running and maintenance costs. Offshore energy functional and structural

components are subjected to numerous damage mechanisms, which concern both materials and coatings. Apart from corrosion and fatigue being the main mechanisms of deterioration in wind turbine structures, blade leading-edge erosion is one of the key challenges in the offshore wind industry as it can reduce the annual energy production by 4% to 20%.

The novel PU coatings designed within MAREWIND project (Grant Agreement 952960) address the main aspects related to leading edge protection. MAREWIND uses TWI approach to integrate functionalized engineered particles to reinforce the state-of-the-art polyurethane top coats and to provide reduced surface energy and nano/micro-scale roughness to achieve high surface repellence. Incorporation of these additives into the polyurethane has been carried out at loading levels in excess of 30% by mass without negative impacts on the processing characteristics. Undertaken Taber test indicated that inorganic fillers improved abrasion resistance by 10%. The superhydrophobic structures attached to those fillers incorporated throughout the thickness of the top coat and intermediate coats provided the retention of high repellence even when the exterior surface started to show the sign of wear. The combination of mechanically durable and hydrophobic solutions will target an increase in service life without repair needs higher than 10 years.

The Simulation of Solar Energy Self-Sufficiency with Satellite Based TMY Data

Sin-Yi Li* and Jen-Yu Han

National Taiwan University, Taiwan

Abstract:

Solar energy is the popular renewable energy in the built environment. The rooftop solar panel can directly connect to the energy system in the building and replace energy supply from local grid. To reach the target of energy transition, the latest policy in Taiwan required that 10% of energy self-sufficient rate is mandatory for industries who signed power capacity contracts over 800kW. This research tried to estimate the rooftop solar energy potential on some of these industries as the example to study the capacity of energy self-sufficiency. By using satellite based typical meteorological year (TMY) data, solar irradiation could be simulated with the same resolution as the satellite image. This approach is helpful to minimise the error oriented from TMY in the regional scope and to pay much attention to searching suitable solar panel to reach the requirement of energy self-sufficient rate

Biography:

Sin-Yi Li is a research assistant at the Department of Civil Engineering, National Taiwan University, Taiwan. He received a bachelor's degree in urban planning from National Chang Kung University (NCKU), Taiwan and two master's degrees in urban planning and planning from NCKU and the University of Manchester, UK. His currently work focuses on solar energy simulation and its indices in digital twins. He is interested in renewable energy approaching, urban energy transition and sustainable city Development.

Design and Optimization of a 25 KW PEM Electrolysis System with Intermittent Power Sources

Victor Eniola*, Jack Cimorelli, Christopher Niezrecki , David Willis and Xinfang Jin

University of Massachusetts Lowell, Lowell, MA

Abstract:

To reduce the CO_2 emissions from heavy-duty transportation and carbon-intensive industrial sectors, green hydrogen has been recognized as a clean alternative fuel. One of the most matured green hydrogen production technologies is the proton exchange membrane electrolysis cell (PEMEC). In this study, a 25 kW PEMEC system will be designed and simulated in MATLAB/Simscape to investigate its performance indicator variation with intermittent wind power source. The electrochemical performance of the PEMEC system will be characterized by a polarization curve, which will be obtained from commercial PEMEC vendors in the United States. To validate the model using the polarization curve, a nonlinear model will be used to optimize the key electrochemical parameters including the cathode and anode exchange current densities, cell conductivity and the limiting current density. Different designs will be made using different nominal operating conditions with the same power source. The optimal design will be achieved with multiple optimization criteria, including cost, reliability and environmental considerations. The tool developed will be made publically available and could be easily adjusted to simulate other electrochemical systems for green hydrogen production.

Biography:

Victor Eniola holds a First Class Honours in Mechanical Engineering and obtained M.Sc. degree with perfect Distinction in Renewable Energy. He has more than ten years of work experience in the energy sector and has worked as a Research/Teaching Assistant at three Universities. Victor is currently a PhD student at the Multiscale Multiphysics Modeling of Electrochemical Systems Laboratory (M3ESL), Department of Mechanical Engineering, University of Massachusetts Lowell where he is actively involved in cutting-edge research in wind energy integration with PEM electrolysis and fuel cell modeling and simulation. He is a registered member of the International Association of Engineers (IAENG).

New Opportunities in Printable Perovskite Photovoltaic Modules

Kai Wang[1]* and Shashank Priya[1,2]

[1]Penn State University, PA

[2]University of Minnesota, MN

Abstract:

Halide perovskite photovoltaics have been rapidly developed over the past decade. Many thrusts have been proposed in this technique for transition. These include high solar to electricity power conversion (PCE) (>25% on small laboratory scale and >20% on minimodule level), low-cost printing manufacturing, and other features such as flexibility and high specific power values. In parallel, issues such as lifetime still remains as the major barrier for this technique. In this talk, I will briefly discuss the strategies to extend the lifetime of the perovskite photovoltaics, from molecular level all the ways to device level.

Biography:

Kai Wang is currently Research Assistant Professor in the Department of Materials Science and Engineering, Pennsylvania State University. Kai received his PhD in Polymer Engineering from The University of Akron in 2017 and joined the Center for Energy Harvesting Materials and Systems (CEHMS), Virginia Tech as a Postdoctoral Associate working with Prof. Shashank Priya. His research contains both fundamental and applied physics in semiconducting materials, and innovations in related devices for multiple applications (such as solar energy harvesting, solar thermal conversion and photon detecting, etc.). Recently his team is developing several new research directions in regarding with low-cost perovskite solar module, bio-inspired new material discovery, and photoelectronic bio-sensing.

Toray Slot-die Coating for Perovskite Solar Cell & Electrochromic Smart Window

Katsumi Araki[1*]

Toray Engineering Co., Ltd., Japan

Abstract:

Toray Engineering Co., Ltd.'s slot-die coater, with the world's #1 sales track record in the LCD color filter industry, is our leading product, having full line-up to the world-largest G10.5 size. With other manufacturing equipment in our listing, we offer equipment to other industries including semiconductor, construction, solar battery, and pharmaceuticals, etc. In the perovskite solar cell & smart window industry too, our leading-edge integrated production line with our slot-die coater playing a key role, can be utilized to wet coat material for them. Various wet coating methods are currently being considered for perovskite, but by applying Toray's slot-die coating technology, it is possible to increase manufacturing efficiency while maintaining quality and scaling-up to larger panels. The examples of our technological focus to uniformly apply photovoltaic perovskite and electro-transport layers especially on large applications shall be introduced in the presentation. The wet coated EC smart window can overcome obstacles in dry coating method and helps realize the mass production of larger glass EC smart window. High-accurate slot-die coater wet deposits electrochromic and electrolyte layer. The advantages of slot-die coater for mass production and market-penetration of the EC smart window, such as equipment cost cut, high material use efficiency and productivity, and glass scale-up capability that are not possible with the conventional vapor deposition method shall also be presented. Toray Engineering is committed to contribute to global energy conservation through spreading perovskite & smart window worldwide with our technology in the manufacturing process of the perovskite & EC smart window.

Biography:

Katsumi Araki has joined Toray Engineering Co., Ltd. in 2017. After spending one year as an engineer for the slot-die coater, he has been working in the Sales Department since 2018. He is mainly in charge of sales and marketing for the manufacturing equipment of perovskite & electrochromic smart glass.

Assessment of Solar Photovoltaic Potential of Selected Site Locations in Cities across Sub-Saharan Africa

Williams S. Ebhota* and Pavel Y. Tabakov

Durban University of Technology, Durban, South Africa

Abstract:

This study estimates the solar photovoltaic (PV) potential of selected cities across sub-Saharan Africa (SSA), using computational modeling. The evaluation will involve sites' location descriptions in the chosen cities with the bearing system (latitude and longitude), coordinate system, or physical address of the sites. The location's description is exploited to obtain the site's meteorological parameters that are used to define or describe the PV potential of a given site's location. These potential evaluation parameters are accessed or generated from the meteorological databases,

such as NREL's National Solar Radiation Database, Explorador Solar, NASA-SSE, and Meteonorm. The solar PV potential is a function of the meteorological and insolation parameters, such as global horizontal irradiance (GHI), diffuse horizontal irradiance (DHI), direct normal radiation (DNI), and global tilted irradiation (GTI). Other meteorological parameters to be considered are relative humidity (RH), speed of wind (SW), and ambient temperature. A hypothetical 10-kWp standalone PV system will be deployed as a PV model to examine the energy production and losses, and rate of degradation of the selected PV cell.

Keywords: Insolation parameters; Solar irradiation; Solar photovoltaic (PV) potential; Meteorological parameters; Solar PV system; Photovoltaic cells, Standalone PV system

Biography:

Williams S. Ebhota is interested in renewable energy options available for net zero-CO2 emissions economies research and development. He holds first, second, and Ph.D. degrees in mechanical engineering. He obtained his first and second degrees from Ambrose Alli University and Nnamdi Azikiwe University, respectively, and a doctoral degree from the University of KwaZulu-Natal, South Africa. He has many years of experience as a research and production engineer. Currently, he is a Research Associate with a specialization in renewable energy technologies at the Durban University of Technology, South Africa.

Parallel Session-II

Fossil Energy

Aluminum as an Energy Carrier for Green Hydrogen Production

Luca Montorsi[1]*, Matteo Venturelli[2] and Massimo Milani[1]

[1]Interdepartmental Center H2 MO.RE - Department of Sciences and Methods for Engineering - University of Modena and Reggio Emilia, Italy

[2]Department of Sciences and Methods for Engineering - University of Modena and Reggio Emilia, Italy

Abstract:

This paper investigates the potential use of aluminum as an energy carrier and resource for hydrogen production. The concept is based on the aluminum – water reaction, which produces hydrogen and a significant amount heat that can be used for super-heating vapour for a steam cycle. The aluminium combustion with water also generates alumina as a by-product; the aluminium oxide can be recycled and transformed back to aluminium. Within this framework, aluminium can be exploited as energy carrier in order to transport energy from the smelter or the alumina recycling plant to the place where the cogeneration system based on the Al-H2O reaction is located. The water is also used in a closed loop; in fact, the amount of water produced employing the hydrogen obtained by the proposed system corresponds to the oxidizing water for the Al/H2O reaction. Even though the system capable of exploiting this concept is still at a research level, the potential benefits in terms of environmental impact and economic assessment encourage the development of the systems into an industrial application. The paper investigates the energy efficiency of transporting and storing energy by means of a aluminum-water reaction based system; similarly the economics of the concept is addressed to estimate a possible cost of the produced hydrogen

Advanced Water-lean Solvent for CO_2 capture Applications

Jak Tanthana*, Paul Mobley, Vijay Gupta, and Marty Lail

RTI International, Research Triangle Park, North Carolina

Abstract:

To make the biggest impact on reducing global carbon emissions, research efforts have focused on removing CO_2 from power plants as roughly 1/3 of the annual CO_2 emission comes from the power industry. Liquid solvents are the most promising in terms of performance and readily deployable at scale. The first-generation of solvent technologies such as aqueous monoethanolamine (MEA) have 2 notable drawbacks: it is energy-intensive (i.e., high operation expense) and it has high capital cost. The high energy demand is attributed mostly to the heat of vaporization of water during the CO_2 regeneration process. The high capital cost stems from the large equipment and expensive materials required to operate a corrosive solvent.

Recently, water-lean solvents (WLS) have emerged as a promising third generation solvent technology with reduced energy requirements due to replacement of the water by an organic diluent. RTI's WLS eCO_2Sol™ has demonstrated low energy requirement at 36-42% reduction compared to that of MEA. In addition, eCO_2Sol™ displays significant performance improvements over MEA such as 4X CO_2 working capacity, 7X faster absorption kinetics, and 100X lower corrosivity. These

performance results have been consistently observed from lab-scale to pilot-scale demonstration throughout its development lifetime. The improved solvent properties of eCO_2Sol^{TM} results in smaller process equipment with lower-cost materials of construction than that of MEA thereby lowering the capital cost. The combination of eCO_2Sol^{TM} formulation and process improvements has resulted in the low-cost CO_2 capture solvent technology that could be implemented at scale across various industries.

Biography:

With 15 years of experience in CO_2 capture technology development Dr. Tanthana has a broad experience with fundamental research in multiphase gas absorption processes as well as technology development specifically in CO_2 capture and conversion space. His engineering expertise includes process design, process scaleup and optimization, emission controls, and techno-economic evaluation. Dr. Tanthana has led multiple federal and internal projects at RTI to expand the application of RTI's proprietary water-lean solvent. He has led multiple efforts that improved process instrumentation and automation on various CO_2 capture system at various scale, ranging from lab-scale to small-pilot units.

A Comparative LCA for Solar-Powered PCC to Unlock the Potential of Steam Preservation for Power Production Only

Dia Milani [a*], Scott Nelson [b], Minh Tri Luu [b] and Ali Abbas [b]

[a]CSIRO Energy Centre, Australia

[b]The University of Sydney, NSW 2006, Australia

Abstract:

To minimize the energy penalty of the PCC, we propose dynamic carbon capture using an innovative solar collector field (SCF). In this project, solar PV panels are used to run electrical equipment (pumps and blowers), and solar thermal collectors to provide the heat for CO_2 desorption via direct solvent regeneration "within the receivers" of the solar collectors. By this methodology, it is anticipated that the typical desorption unit including the complex stripper and the reboiler can be eliminated from the process flowsheet, and the notion of solar assisted PCC (SA-PCC) is elevated to a new frontier of "solar-powered" PCC (SP-PCC).

Apart from the economic complications, the comparative environmental impact of these various technology options is mostly unknown as they defer largely by the PCC equipment, land-use pattern, and the amount of steam generated in the SCF or bled from the power cycle. Accordingly, the global warming potential (GWP) would require a comprehensive cradle-to-grave life cycle analysis (LCA). The key objective of this study is to assess whether the solar contribution particularly in the SP-PCC scenario has notably enhanced the sustainability of the carbon capture process. It is found that SP-PCC can show a greater GWP abatement particularly at larger flue gas uptake ratios. The overall GWP abatement on the cradle-to-grave scale is greater by 19.7% for a 660 MWe and 39.3% for a 330 MWe power plant, respectively. Sensitivity analyses also indicate that increasing the solar multiple (SCF size) can substantially improve the GWP abatement because of proportionally lowering the GWP of the solvent storage, but that would also have an impact on the land use of the SCF. Overall, efforts to reduce the cost of CO_2 capture via SP-PCC will be greatly advantageous for the incorporation of SP-PCC into existing coal-fired power plants to effectively mitigate the global warming related to coal consumption.

Biography:

Milani is a Senior Research Scientist and a Team Leader at the Commonwealth Scientific and Industrial Research Organization (CSIRO). He has been involved in several research, pilot scale projects and energy auditing panels. His research focuses on the water-energy-emission nexus with primary emphasis on novel technologies in renewable energy, energy storage, carbon capture, CO_2 utilization, and solar-assisted power cycles. Dia's goal is to autonomize carbon capture processes away from fossil fuels and grid connection to be fully sustainable and independent technologies. Dr Milani has recently been awarded the prestigious CSIRO's Julius Career Award in recognition of his exceptional work in pushing cutting-edge technologies.

BIO-CAPTURE AND CO_2 SEQUESRTRATION WITH MICRO-ALGAE *Phormidium valderianum*

Sivasubramanian Velmurugan[1*], Maya Suresh Nair[1] and Ravikumar Rajarathinam[2]

[1] National Institute of Technology Calicut, Kozhikode, Kerala-673601 India (www.nitc.ac.in)

[2] Center for Bioenergy and Bioproduct Development, Vel Tech

Rangarajan Dr. Sagunthala R and D Institute of Science and Technology, Avadi, Chennai, India (www.veltech.edu.in)

Abstract:

Carbon sequestration is the process involved in carbon capture and the long-term storage of atmospheric carbon dioxide or other forms of carbon to mitigate or defer global warming. It has been proposed as a way in order to bring down the atmospheric CO_2 level which is usually released by burning of fossil fuels. Cyanobacterium, commonly known as blue green algae is a promising organism for CO_2 sequestration. In the present study, the microalgal strain, *Phormidium valderianum* was potentially used to capture gaseous CO_2 with varying range of CO_2 concentration (5-30%). Another set of microalgal isolates were grown in ASN -III medium supplemented with sodium bicarbonate ($NaHCO_3$) as a carbon source. The growth behavior of the isolates and rates of $NaH^{14}CO_3$ uptake were considered as screening parameters to determine the maximum growth of microalgal strain. A biomass productivity of 0.66 ±0.027 $gL^{-1}day^{-1}$ and a rate of CO_2 fixation as nearly $25g^{-1}day^{-1}$ was obtained for 30% CO_2 concentration. This study also focussed the increase in protein production rate for different CO_2 concentrations and the protein concentration doubled with the introduction of 30% CO_2. Additionally, the influence of pH was also investigated on the CO_2 sequestration by the microalgal strain. Furthermore, our study showed that microalgae, *Phormidium valderianum* will be an excellent alternative to forced CO_2 capture.

Biography:

Sivasubramanian V is working as Professor of Chemical Engineering in NIT Calicut, India from 2007 onwards. Five years of Industrial Experience as Senior Plant Engineer. Current research areas are Carbon Capture, Cadmium Removal, Electrocoagulation and Wastewater Treatment. Felicitated with 22 Awards (National and International). Published 90 International Peer Reviewed Journal papers, 110 Conference papers and 8 Book Chapters. Edited 7 Books. Editor in 8 reputed International Journals. Reviewed 125 Papers in 70 Journals. Visited Seven countries and attended International Conferences. In 2019, visited Indianapolis, USA and presented a paper. Handled 6 sponsored projects. Guided 17 PhD students and 3 ongoing.

Examining Contact Liquids for the Cryogenic Carbon Capture™ Process

Christopher Wagstaff*[,1] Mohammed Alarfaj[1,2], Jahirul Mazumder[1] and Mohammed Juaied[1]

[1] King Abdullah University of Science and Technology, Saudi Arabia

[2] High School Intern, Saudi Research Science Institute

Abstract:

The Cryogenic Carbon Capture™ (CCC) process has been described as a process with "the greatest potential" because of its energy savings and plug-and-play ability. The CCC process captures carbon dioxide from flue gasses by directly contacting with a very cold contact liquid which induces separation by desublimating the CO_2 and not the N_2. The focus of this study was to examine different alternatives for contact liquids by discussing their potential advantages, disadvantages and niches. Three potential niches include 'normal' operation at -130 °C which leads to ~97% CO_2 capture, operation at less than -147 °C which would lead to greater than 100% capture or 'net-direct air capture, and lastly operation with high SO_2 content. First, these niches are discussed by examining several tabulated properties for 14 chemicals: melting point, vapor pressure, heat capacity, cost, and solubility of CO_2, solubility of SO_2, and environmental impact. Second the most limiting property of melting point (or pour point) was experimentally measured for several sets of binary mixtures with particular attention to the more promising systems of isoprene/n-pentane and silicone oil mixtures. Screening results indicated that Isopentane/n-pentane remains one of the best (although not ideal) options for -147 °C operation. Additional results indicate that isoprene may be a greener alternative to isopentane. Adding n-pentane to isoprene produces a freezing point depression. This may be desirable for cheaper or lower temperature operation, although there is a tradeoff with environmental friendliness.

Biography:

Christopher Wagstaff graduated *cum laude* with a Bachelors from Brigham Young University in 2017 and graduated 'with distinction' with a Masters from Imperial College London in 2018. His master's thesis dealt with designing a membrane for the largest (by molecular weight) chiral separation to date. He is currently working on his PhD at KAUST (King Abdullah University of Science and Technology). At KAUST he is continuing his interest in separation technologies where he is improving low-temperature carbon dioxide capture from effluent streams.

A Cloud-based Smart Building Platform with Integrated Technologies to Increase the Energy Efficiency of Buildings

Saruf Alam

KODE Labs Inc, Detroit, MI

Abstract

According to a 2015 quadrennial report from the U.S. Department of Energy, commercial real estate utilizes 76% of all electricity generated by the U.S. Furthermore, the same study states that the energy consumed by the building sector accounts for 40% of the greenhouse gas emissions produced by the country. Consequently, the CRE industry is presented with an opportunity to have a sizable impact on the sustainability of a country and the world.

KODE Labs is a "smart building" platform that has integrated legacy building technologies, such as Heating, Ventilation and Air Conditioning (HVAC) or lighting with newer IOT sensing solutions such as occupancy sensors in order to improve building efficiency. This platform has presented

multiple tools that automate equipment runtime and diagnose underlying issues, both which help decrease energy consumption by improving a building's operational efficiency. One such tool is KODE's Optimized Start-Stop module. This module calculates when users are entering/exiting the building through leveraging occupancy sensors, and computes based on equipment performance and external weather conditions, the latest possible startup time for the building's HVAC system. OSS has shown to reduce equipment runtime by up to 40%, presenting energy savings of up to 30%. KODE's Functional Testing Tool (FTT) is another tool that allows users to automatically test and score their building equipment based on a customizable sequence of operations. On average, FTT has been able to test 80% of a building's equipment and surface previously undiagnosed issues amongst around 20% of the tested sample.

Biography:

KODE Labs is a 5 year old software startup with over 200M + sqft of commercial real estate utilizing their software platform. As the Director of IoT at KODE Labs, Saruf Alam has deployed many smart building projects with multi-million dollar budgets for large clients in North America, Australia and Europe. His main project last year was to design and implement KODE OS for a new 350,000 square foot building in Austin, Texas. This building, RiverSouth, won the award for the most Intelligent Office Building in North America in 2021.

Carbon Capture and Utilization at City Water, Light and Power in Springfield Illinois

Leslie M. Gioja[1]*, Kevin C. OBrien PhD[1], Larz-Erik Goertner[5], Brandon Hursh[3], Sunggju Kang[2], Stephanie Brownstein[1], Sebastiano Giardinella[1], David Hazlebeck PhD[4], Ryan Larimore[1], Lance Schideman PhD[1], Bajio Varghese Kaleeckal[1] and PJ Becker[6]

[1]Illinois Sustainable Technology Center, Prairie Research Institute, University of Illinois at Urbana-Champaign, USA; [2]Doosan Heavy Industries and Construction, South Korea; [3]Kiewit, USA; [4]Global Algae Innovations, USA; [5]Linde ASF Corporation, Germany; [6]City Water Light and Power (CWLP), USA

Abstract

The City Water, Light, and Power (CWLP) power plant supplies both electricity as well as water to the city of Springfield, Illinois – capitol of the state of Illinois. CWLP currently relies heavily upon Illinois coal and needs to reduce greenhouse gas emissions. Like many other power plants throughout the United States and the world, CWLP must make major, but cost-effective modifications in its hardware and technology to meet current and future demands for clean, renewable, reliable, and affordable energy.

There are three projects underway at CWLP to study/demonstrate these needed technologies. *These were made possible through funding and support from the U.S. Department of Energy's Office of Fossil Energy and Carbon Management (DOE/FECM), National Energy Technology Laboratory (NETL), and CWLP.*

a) A novel, large-scale Linde-BASF advanced post-combustion capture (PCC) pilot using a 10 MWe slipstream from Dallman #4 coal boiler is under construction. This project will soon demonstrate an economically attractive and transformational capture technology that can be retrofitted at existing plants and deployed at new plants.

b) An algae-based utilization pilot using a small slipstream from Dallman #4 is under construction and partially operational.

c) A 21st Century Power Plant utilizing a Hybrid Gas Turbine and Ultra-Supercritical (USC) Coal Boiler Concept with PCC, Energy Storage System, and Algae-based utilization is starting Phase 2 of a FEED study. The study includes use of alternative fuels. Flexible, innovative, resilient, small,

and transformative; this plant will meet fluctuating customer needs, increased renewables on the grid, technology advances, and changes in environmental requirements.

Biography:

Les Gioja has worked for the University of Illinois - Illinois Sustainable Technology Center since 2020, where he managed Compressed Natural Gas Energy Storage, Direct Air Carbon Capture and Utilization, and 21st Century Power Plant projects. He has also provided support for funding proposals and other active Carbon Capture and Utilization projects. He has a B.S. and M.S. in civil engineering from the University of Illinois. He has worked as a nuclear-trained submarine officer, a civil and structural engineering consultant, a college-level instructor, a city engineer and zoning administrator, and a facility engineer for the Army Corps of Engineers.

Taking Advantage of Brazilian Agroindustrial Residues Aiming to Produce Lipases for Biodiesel Production

Mariana Moreira Sidel Maia[1], Ana Caroline Pereira Dias[1], Fernanda Perpétua Casciatori[2] and Lina María Grajales[1]*

[1]Federal University of Tocantins (UFT), Graduate Program of Digital Agroenergy, Brazil

[2]Federal University of São Carlos (UFSCar), Graduate Program of Chemical Engineering, Brazil

Abstract

This work aimed to analyze the lipases production from the fungus Metarhizium anisopliae by solid-state fermentation (SSF). Babassu coconut bagasse, soy bran (from oil extraction and soy milk production), broken rice, wheat bran, and corn bran were used as substrates. Pretreatments on the substrates and the use of an inducing agent (olive oil) were carried out to verify their necessity on lipase production. Preliminary experiments showed that for babassu coconut bagasse there is no need for pretreatment. The results showed that there was no statistical difference in lipolytic activity between broken rice and soybean bran when the experiments were performed with or without pretreatment. Pretreatments for corn bran and soybean bran showed a statistical difference in the results. The highest enzymatic activities were obtained for the experiments carried out without pretreatment. Therefore, subsequent fermentations were carried out without pretreatments. Regarding the experiments without using inducers, soybean bran (residues generated after soy milk production) was the one that showed the highest enzymatic activity. Wheat bran had the lowest enzymatic activity. Concerning the experiments carried out with the inducer, the substrate that presented the highest enzymatic activity was the babassu coconut bagasse. Soy bran had the lowest enzymatic activity. In conclusion, for all the treatments evaluated, the highest enzymatic activity obtained was for the experiments carried out with babassu coconut bagasse as a substrate, using an inducing agent, and without using any type of pretreatment. The next step will consist of the biodiesel production from the lipases produced.

Biography:

Chemical Engineer graduated from the National University of Colombia, UNAL. She holds a master's and doctoral degree in Engineering and Food Science from São Paulo State University, UNESP. She has a Postdoctoral internship in Chemical Engineering at UNAL. She is a Professor at the Federal University of Tocantins, UFT, in the undergraduate course of Food Engineering and in the Graduate Program of Digital Agroenergy. She is a coordinator of the Support Group for Foreigner Students. She coordinates the Research Group "Bioreactor Engineering". Her expertise area is in developing rotary-drum and fixed-bed bioreactors for Solid-State Fermentation aiming at biofuels production.

A New Hyperloop Ground Source Heat Pump System Used in a Single-Family House

Yao Yu[1]*, Rui Miao[1], Xiaoou Hu[1] and Richard Gordon[2]

[1]North Dakota State University, USA;

[2]Gordon & Associates, Inc., USA

Abstract

Ground Source Heat Pump (GSHP) systems have the potential for achieving high system efficiencies. Various types of in-ground heat exchangers have been developed to optimize the performance of using them with heat pump systems for space heating and cooling of buildings. In this presentation, a new Hyperloop Ground Source Heat Pump system is introduced, and then the results of numerical simulations about using this type of system in a typical singlefamily house located in a cold climate of the US are followed, which show that the use of hyperloop in a GSHP can not only meet the heating and cooling loads but also achieve higher efficiency and lower energy consumption, compared with a conventional vertical GSHP system. Hyperloop is a new type of ground heat exchanger, which consists of multiple capillary noncorrosive polymers tubes buried horizontally and vertically on edge, as a flat mat, in shallow ground. It can be easily installed under existing building structures and/or an adjacent driveway, etc. Different types of engineered fill materials, such as sand, etc., can be used to enhance the heat transfer and energy storage in the in-ground region to optimize the efficiency of a heat pump system.

Biography:

Yao Yu earned his two Master degrees and one Ph.D. in Architectural Engineering, Civil Engineering, and Computational Science and Engineering in 2008, 2012, and 2014, respectively. After graduation, Dr. Yu worked in industry as an energy engineer to perform building energy modeling and simulation. He is a LEED Accredited Professional and an ASHRAE Building Energy Modeling Professional (BEMP). Currently, Dr. Yu is working as an assistant professor in the Department of Civil, Construction and Environmental Engineering at North Dakota State University.

The Role of Numerical Simulation into Energy Intensive

Matteo Venturelli* [1], Massimo Milani[1] and Luca Montorsi[1]

[1]University of Modena and Reggio Emilia, Italy

Abstract

This paper focuses on the development of numerical methodologies for the accurate performance prediction of systems and technologies that can be applied to industrial processes for their energy efficiency enhancement and environmental footprint reduction. Firstly, the numerical analysis has been applied in the ceramic industry to investigate the thermal fluid dynamic behavior of the kiln. A lumped and distributed parameter model of the entire system is constructed to determine the energy efficiency, the natural gas consumption of the burners and the quality of the final product. A CFD approach has been developed to calculate the heat transfer coefficient between the materials and furnace components. A numerical-experimental validation has been carried out. The model is used to analyze different solutions for the enhancement of the energy efficiency, such as the effects of the exhaust recovery or different control strategies that optimize the system performance and quality of the products. In the food industry, the numerical simulation is used for addressing the actual operation of a filling machine for the beverage packaging process. The hydraulic system of machine is constructed. The numerical model is employed to analyze the flow dynamic within the piping and the hot welding process of the packaging. The numerical models

developed demonstrate to be efficient tools for investigating the performance of energy systems in different industrial sectors. Analyzing the solution optimization, studying the integration in the existing industrial processes and evaluating the economics of the design are some of the goals that can be reached with numerical simulation.

Biography:

Matteo Venturelli obtained a PhD in "Industrial Innovation Engineering" in 2022 at the University of Modena and Reggio Emilia and he is currently working as a researcher at the Department of Science and Methods for Engineering in Reggio Emilia. His main research interest is the development of numerical methodologies and tools for the simulation of the energy efficiency in industrial processes. Matteo is studying also innovative energy systems for the clean energy production and energy recovery that aims at reducing the environmental impact of industrial processes promoting a circular economy.

COVID-19 simulation in Madrid with WRF/Chem and CAMx models

Roberto San José* and Juan L. Pérez-Camaño

Technical University of Madrid (UPM), Campus de Montegancedo, Boadilla del Monte, 28660, Madrid, Spain

Abstract

The impact of COVID lockdown on the urban air quality is estimated by running two simulations, one simulation considers the emission reductions during the lockdown (COVID simulation) and a second simulation," business as usual" (BAU simulation) with an emissions scenario without restrictions. The objective of this work is to analyse how the air quality responds to the emission reductions during COVID-19 lockdown in the city of Madrid (Spain) and to understand the air pollution concentrations attributed to both source regions and emission categories combining force brute method and source apportionment methodologies. The simulations have been run with the Weather Research and Forecasting model (WRF) with Chemistry (WRF/Chem) model and the CAMx with its extension SAT (Source Apportionment) to estimates the contributions from multiple source areas, 12 emissions categories and boundary conditions for O3 (OSAT) and PM (PMSAT). Modelling tools performance have been analyzed comparing the hourly simulated concentrations with observational hourly data from the Madrid municipality and regional air quality observation networks. The reduction of emissions mainly from the transport sector has produced the high reduction of NO2 concentrations, moderate reduction of PM10 and PM2.5 concentrations and increase in O3 concentrations (secondary pollutant). Boundary conditions are the main source of the air pollution concentration (40-50%). The O3 formation is dominated by VOC limited situation. This produces increases of O3 during the lockdown period (NOx reduction). Solvent use is the main emission source and the zones located in the South of the city are the main contributors.

Biography:

Roberto San Jose completed his PhD in 1982 related to the unstable surface turbulent boundary layer parameterisation. He has been involved in air pollution modelling mainly using three dimensional mesoscale models, such as MM5 and CMAQ. He created the Environmental Software and Modelling Group at Computer Science School of the Technical University of Madrid (UPM) in 1992. He spent one year at the Max-Planck Institute for Meteorology and two years at IBM-Bergen Environmental Sciences and Solution Centre. He has more than 150 publications in different national and international scientific journals. He has been a Full Professor since 2001.

Passive Solar Home Design for Low-Cost Zero-Energy Housing in the United States

Jasmina Burek[1], Yicheng Zhang[1], Blake Davison[1], Mahsa Ghandi[1], Jeremy Gregory[2] and Randolph Kirchain

[1]University of Massachusetts Lowell, USA,

[2]Massachusetts Institute of Technology, USA

Abstract

A zero-energy building (ZEB) is an energy-efficient building which generates renewable energy on-site and offsets and/or exceeds the energy used from the electric grid. The most accessible and affordable on-site renewable energy source for residential buildings is solar photovoltaics (PVs). ZEBs must be 50% to 70% more efficient than conventional buildings. Thus, we choose a passive solar house design, which is a standard for energy efficient, comfortable, and affordable building with roof mounted solar PV system. A probabilistic building life cycle assessment tool for residential buildings called the Building Attribute to Impact Algorithm (BAIA) was used to analyze passive house embodied and operational energy and related environmental impacts and costs based on building geometry, assemblies, system attributes, regional U.S. electricity production, and climate zones. BAIA uses Monte Carlo analysis to simulate results for thousands of unique passive house designs. For the zero-energy requirement of the building, we created a solar PV model based on geometry outputs from BAIA to determine solar PV panel allowable size, energy production, total cost, and cost savings over their lifetime. We will present preliminary results for two cities, Boston in Massachusetts (MA), and San Francisco in California. The main differences between two locations were: energy cost, electric grid, and solar irradiation.

Biography:

Jasmina Burek (she/her/hers) is an Assistant Professor in the Mechanical Engineering Department at the University of Massachusetts Lowell (UML) and Principal Investigator at BUilding REsilience through Knowledge (BUREK) Lab. Her research focuses on sustainability and resilience engineering. She develops decision-making models to measure and minimize environmental, social, and economic impacts (footprint assessment) of products, materials, buildings using life cycle assessment (LCA). She has over 15 years of LCA method application in areas of buildings, energy, and product supply chains. At UML, she is moving towards the research in resilient buildings and developing LCA method to account for it.

Clean and Efficient Plasma Technologies for Liquid Fuel and Natural Gas Conversion

Kunpeng Wang[1*], David Staack[2], Rollie Stanich[1], and Howard Jemison[1*]

[1]LTEOIL, 2929 Allen Parkway, 200, Houston, TX

[2]Mechanical Engineering, Texas A&M University, College Station, TX

Abstract

LTEOIL and Texas A&M University have developed multiphase non-equilibrium plasma processes to continuously convert hydrocarbons into hydrogen and hydrocarbon liquids and/or carbon solids. These innovative electrical driven processes have resulted in a significant GHG emission reduction and could be incorporated with existing Oil & Gas infrastructure. Multiple processes are being developed and scaled up to work with various feedstocks including fossil fuels, biofuels, and natural gas. When natural gas is the feedstock, a hydrogen rich gas was produced. The hydrogen is available for purification, and a fuel cell using this hydrogen may supply enough energy to power the entire

process. The LTEOIL process operates at near ambient conditions and requires no catalyst. With minimal startup energy and other inputs, the LTEOIL process—powered by self-generated clean electricity—demonstrates an highly efficient flare reduction or elimination method. The current relatively low hydrogen production cost (~$1.5/kg-$H_2$), robustness, scalability, and modularity of the LTEOIL process also indicates a promising future for hydrogen production in the refining, gas processing and petrochemical industries. This production cost is already well below those of green hydrogen from electrolysis and blue hydrogen from steam reforming of methane with carbon capture with the reality of NZE hydrocarbon energy and is well on the way to Energy Secretary Jennifer Granholm's "earthshot" target of sub $1.00/kg H_2 by 2030. LTEOIL is thus creating "teal" hydrogen, a new color of hydrogen which achieves the benefits of both green and blue, while mitigating their liabilities.

Biography

Kunpeng Wang received his PhD degree in 2019 from Texas A&M University and has more than ten years' experience working on non-equilibrium plasma conversion of fuels, clean hydrogen production, nanomaterial synthesis, and industrial applications of high energy electron beam.

Sustainable Value Chains Towards Specialties and (Aviation) Fuels Based on Low-Temperature PEM-Water Electrolysis and Syngas Fermentation

Guenter Schmid* [1], Heinz Neubert[1], Philipp Lettenmeier[1], Andre Klinger[1] and Thomas Haas[2]

[1] Siemens Energy Global GmbH & Co. KG, Germany

[2] Evonik Operations GmbH, Germany

Abstract

1. Sustainable value chains by coupling electrolysis and fermentation The energy transition needs a raw material transition. The process sequence of water electrolysis and syngas fermentation provides access to C4-C6 based value chains based on CO2 and H2. In the German Kopernikus and Rheticus projects Siemens Energy Global GmbH & Co. KG (SE) and Evonik Operations GmbH focused on a sustainable synthesis of C6-oxygenates for specialty chemicals, food additives and even fuels. Routes to kerosene exist. The technology was successfully implemented in chemical plant environment at Marl with an annual production capacity of ~15t. The scaling into the multimillion-ton annual production range depends on various boundary conditions, such as the availability of renewable energy at competitive cost, the political situation as well as its customer acceptance.

2. Silyzer 300 PEM electrolysis SE is one of the key companies willing to implement the German National Hydrogen Strategy until 2030. The current product is named Silyzer 300® with 17,5 MW rated power at begin of life on system level. The stack core consists of a non-pressurized array with 24 modules, producing around 335 kg of hydrogen per hour. SE is investing more than 60 Mio.€ for the massive ramp-up of electrolyzer production capacity through automation. Series production and de-risking, qualification for large-scale application are funded within the H2Giga program.

3. Perspectives in AEM-Membranes Anion Conducting Membranes offer design and operation options in polymer membrane water electrolysis. Electrochemical data will be presented with respect to noble metal free catalysts and choices of membranes

Biography:

Gunter Schmid is a Principal Key Expert Research Scientist in the newly founded Spin-off Siemens

Energy Global GmbH & Co. KG in the unit Transformation of Industry – Sustainable Energy Solutions – Product Management. He earned his PhD degree from the University of Ulm and joined Texas A&M University for a postdoc position. Since 1996 he is working within the industrial framework of Siemens companies like Siemens Energy, Siemens AG, Infineon AG and Osram in various positions. Focus areas are electro catalysts, gas-diffusion electrodes, industrial electrochemical cell design and operation conditions. Recently, degradation issues in Megawatt PEM electrolysers found his attention.

Atomization and Combustion Performance of Novel Twin-Fluid Injection for Next-Generation

Lulin Jiang*

Baylor University, USA

Abstract

A novel fuel-flexible injector with potentially transformative atomization capability has been developed recently. The novel injector generates fine droplets at the injector immediate exit, rather than a typical liquid jet/sheet of conventional injectors. Clean and efficient combustion of liquid fuels highly depends on spray fineness. Fine sprays evaporate fast, mix well with the oxidizer, thus lead to complete and clean premixed combustion. Otherwise, larger droplets of conventional atomization burn incompletely or at diffusion mode with low efficiency and pollutant emissions. Due to the superior atomization, the novel atomizer has resulted in complete combustion of fossil fuels with minimized emissions. Furthermore, fine sprays were acquired for highly viscous source oils (e.g., algae oil) of biodiesel and its waste product – glycerol, which are about fifteen and two hundred times more viscous than diesel respectively. Thus, the novel injection also enabled clean premixed flames of these fuels, without fuel preheating nor hardware modification, potentially enabling near-zero emission combustion due to the closedcarbon cycle of biofuels. Direct clean combustion of these fuels eliminates the conversion cost of the source oils and thus enables cost-effective biofuels. Moreover, the fine atomization can also impact many other spray applications such as fire suppression, food processing, drug delivery, and additive manufacturing.

Biography

Lulin Jiang earned her BS degree with Honors in Thermal Energy and Power Engineering at North China Electric Power University (NCEPU) in China in 2005. She received her master's (2013) and Ph.D. (2014) degrees in Mechanical Engineering from The University of Alabama, where she learned from Dr. Ajay K. Agrawal, the former Chair of the U.S. National Combustion Institute. Dr. Jiang's research interests are mainly in design of thermal fluid systems, atomization and combustion for clean energy, and advanced laser diagnostics. Her research team is primarily devoted in co-optimization of transformative atomization techniques and next-generation combustion and propulsion systems.

Structural Evolution and Nanostructure of Thermoelectric Materials

Norbert M. Nemes*[1], Javier Gainza[2], Federico Serrano-Sánchez[2], Oscar J. Dura[3], Neven Biskup[1], José-Luis Martínez[2], Juan J. Meléndez[4], Michael M. Koza[5], María-Teresa Fernández-Díaz[5] and José-Antonio Alonso[2]

[1]Universidad Complutense de Madrid, Spain

ABSTRACTS

[2]Instituto de Ciencia de Materiales de Madrid, Spain

[3]Universidad de Castilla La Mancha, Spain

[4]Universidad de Extremadura, Spain; [5]Institut Laue–Langevin, France

Abstract

A good thermoelectric material must have a high Seebeck coefficient (S), be a good electrical conductor and a good thermal insulator. The efficiency of a thermoelectric is commonly characterized with its thermoelectric figure of merit, $zT=\sigma S^2T/\kappa$. Thermoelectrics could play an important role in saving energy in a future, sustainable, economy, if only they had a zT>4. Today, the best materials, commercial highly doped semiconductors, do not exceed by much zT ~ 1, while state-of-the-art zT reported very recently in materials such as SnSe or GeTe do not exceed zT ~ 2.5. There are several strategies pursued to improve thermoelectric properties, including nanostructuring, or the "phonon glass, electric crystal" approach, aiming to decrease the lattice thermal conductivity, while preserving good electronic properties.

We use straight-forward arc-melting synthesis to obtain thermoelectric materials with promising properties. We characterize the static and dynamic structure with neutron scattering, with Rietveld refinement analysis to obtain both the crystalline structure and the dynamics of the constituent atoms through thermal factors.

We correlate the structure with the thermoelectric properties, in particular with the contribution of the crystalline network to the thermal conductivity in families of intermetallic alloys: Bi_2Te_3, GeTe, PbTe, and finally SnSe, where we obtained the highest figure of merit (zT~1.8) to date in any n-type polycrystalline sample. In this talk several examples of these material families will be described, always aiming to establish correlations between the structural peculiarities with the observed properties.

Biography:

Norbert M. Nemes is an experimental solid state physicist who obtained his PhD in Physics from the University of Pennsylvania in 2002 and after postdoctoral stays in the NIST Center for Neutron Research and also the Materials Science Institute of Madrid he is a Professor of Applied Physics at the Universidad Complutense de Madrid, one of the largest and oldest Spanish universities. He has published over 100 research papers with an h-index of 24 on topics ranging from materials of reduced dimensions, superconductors, spintronics and magnetic anisotropy, multifunctional materials (magnetoelectric coupling), and in the last years on thermoelectrics.

Origins of Unique Structural Phase Transitions for Nuclear Fuel Cycle Materials

Addis S. Fuhr,[a] * Ashley Shields,[b] Erik Nywkest,[b] Zachary Brubaker,[b] Jennifer Niedziela,[b] and Andrew Miskowiecb

[a] Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, TN, United States

[b] Nuclear Nonproliferation Division, Oak Ridge National Laboratory, Oak Ridge, TN

Abstract

AB2 intermetallic compounds known as Laves phases have many proposed applications such as high-temperature stable ferritic steels, or wear-and corrosion-resistant materials. UAl2 is a uranium-based Laves material that forms as a byproduct of the nuclear fuel cycle after irradiation of uranium fuels (e.g. U-Mo, U-Si, or U3O8) in aluminum matrices. Interestingly, UAl2 can form in either the C15 or the C36 phase, which is rare for Laves materials (e.g., less than 5% of known Laves

structures form in the C36 phase, and UAl2 is the only known actinide Laves material to show an experimentally observable C15 à C36 transition). Here, we apply first principles calculations to determine the origin of the C15 à C36 phase transition, and describe the corresponding physics of each phase. We elucidate the relationship between chemical bonding, phononic, and electronic contributions to the C15 à C36 phase transition and relate these findings to the thermal and magnetic properties UAl2 Laves phases.

Tuning the Structural and Electronic Properties of Titanium Dioxide for Energy Storage

Zhongkai Hao* and Guo Qin Xu

National University of Singapore (Chongqing) Research Institute, China

Abstract

Titanium dioxide (TiO_2) is one representative electrode material for Li-ion batteries with a high theoretical capacity of 335 mAh g^{-1}. However, due to the intrinsically low electrical conductivity and poor ion diffusion coefficient, pristine TiO_2 anodes exhibit unsatisfactory electrochemical performance. To further improve the Li-ion storage capacity and long-term cyclability, many approaches were developed to fabricate TiO_2-based materials through nanosizing, doping, or forming composites. In my works, three efficient material engineering/modification ways, including architectural optimization, the presence of oxygen vacancy and the introduction of oxygen vacancy with structural disorderness, have been developed and adopted to ameliorate the physicochemical properties of TiO_2 particles, thus improving their energy storage properties in specific capacity, rate capability, and cycle stability. More importantly, these works not only exhibits the enormous advantages of multiple TiO_2 architectures, but also provides open access to reasonable structural design and modification for TiO_2-based anode materials for efficient energy storage.

Biography:

Zhongkai Hao received his B.S. in Polymer Materials and Engineering from Changzhou University, China in 2013, M.S. in Industry Catalysis from Shanghai Normal University, China in 2016, and PhD degree in Chemistry from National University of Singapore, Singapore in 2021. He is currently a postdoctoral research fellow under Prof. Guo Qin Xu in NUS (Chongqing) Research Institute. His research interests focus on the design and fabrication of advanced electrode nanomaterials for energy storage.

Performance of Nonlinear Energy Sink with a New Mechanism on Energy Dissipation Systems

Liming Dai* and Kamran

Foroutan Industrial Systems Engineering, University of Regina, Canada

Abstract

Dynamic motion especially nonlinear dynamic motion of engineering systems is usually considered as negative as it wastes energy, raises heat and may cause failure of the systems. In recent years, Nonlinear Energy Sink (NES), which can be connected to the systems via nonlinear elastic structures, shows efficiency in absorbing energy of dynamic systems and therefore controlling the motion and vibrations. In this research, a new mechanism consisting NES is presented for reducing the dynamic motion of energy dissipation systems. The dynamic behaviors of a two-degree-of-freedom

system composed of a linear oscillator and a coupled NES including very light mass, spring, and damper, are investigated. In order to decrease the vibration response of the host single degree of freedom system, an NES with the new mechanism is enforced. The NES possesses both nonlinear local and linear global potentials. The global potential consists of a linear elastic structure that is connected to linear oscillators and makes direct interactions with the linear oscillator. Whereas the local potential consists of both cubic nonlinear and negative linear spring which is connected to the ground and depends on its behavior during the vibrational energy exchanges between the two oscillators. Nonlinear governing equations are derived in this research. Utilizing the harmonic balance method around 1:1 resonance, the response of the system is analytically obtained. A slow invariant manifold is obtained and the effects of various parameters on the dynamic of the two-degree-of-freedom system are investigated. Biography: {Max words limit 100} Prof. Liming Dai, PhD, PEng, ASME Fellow, is a professor of Industrial Systems Engineering at the University of Regina, Canada. He was a chief engineer and plant manager of a company in Canada. His research areas include nonlinear dynamics, numerical simulation of higher accuracy, vibration and noise measurement and control, EOR with seismic and vibration stimulations.

ESG Investment, Green bond, Carbon Tax and Optimal Portfolio Allocation

Naoyuki YOSHINO[1] and Tomonori Yuyama[2]

[1]Keio University, Financial Research Center, FSA, Government of Japan

[2]Financial Research Center at FSA, Government of Japan.

Abstract

Amid the importance of environmental issues, the United Nations has indicated sustainable development goals and ESG investment (Environmental Social and Social) investment behavior in consideration of Governance) is required. In both cases, it is recommended to take investment actions while considering the environment, rather than investing only at the "return and risk", which was the conventional investment target. In this paper, we focus on the environment and proceed with discussions. Each global valuation body defines ESG and SDG targets and proposes advising them to adopt environmentally friendly investment behavior as well as conventional "risk/returns." However, at present, the definitions of ESG and SDG differ from evaluation organization to evaluation institution. Therefore, I would like to explain by the theoretical model that each investor's investment behavior may differ depending on which evaluation institution's criteria are followed, and the optimal asset selection may be distorted. Similarly, green investment is based on its principles is shown in Europe. For example, if funding for renewable energy is a fundraising for renewable energy, a green bond can be issued, but one green bond is a "green project that reduces CO2 emissions by about 80%" and another green bond is a "green project that reduces CO2 emissions by about 90%", but both investments issue green bonds, It is considered a green investment. Therefore, green investment may also distort the optimal asset allocation under current standards. In order not to generate such distortions, it will be explained below that the method of changing the asset allocation of investors by reducing the return (return on investment) of companies that emit a large amount of exhaust gas by imposing the same tax rate on waste gas SUCH as CO2 and plastics worldwide is a method that does not distort the optimal asset allocation. (Yoshino, Taghizadeh-Hesary and Otsuka (2021)、Yoshino and Yuyama (2021))。 Carbon taxes should impose the same tax rate on all countries. Otherwise, tax loopholes lead companies to action to avoid the burden of carbon taxes by moving production sites to countries with lower tax rates.

Placing a heavy carbon tax on Japanese companies must be avoided from an international competitive point of view, and it is necessary to impose the same tax rate globally, and the amount

of efforts deducted efforts to reduce CO2 emissions through efforts such as investment in forests to reduce CO2 emissions and offshore wind power construction. It is desirable to tax companies by measuring their CO2 emissions online. In addition, the new corona infection has led to an increasing budget deficit in each country, and the carbon tax will serve as a new global source of revenue and accelerate the resolution of environmental problems. However, the carbon tax is a decreasing tax in 2050, when carbon neutrality is achieved. In order to respond to the increasing social security and pension spending under the aging of the population, it is necessary to delay the retirement period and build an employment system that will continue to contribute to society for as long as possible, and it is desirable as an important structural reform to lead to a reduction in the budget deficit by building a salary system according to productivity rather than a seniority wage system (Yoshino and Miyamoto (2016))。

Modelling CO_2-brine flow in cores extracted from reservoirs with millimeter-scale Accuracy

Avinoam Rabinovich and Evans Anto-Darkwah

Tel Aviv University, Tel Aviv, Israel

Abstract

Modelling CO_2 storage in subsurface formations is a challenging task with many open questions. An important tool for investigating these flows on the laboratory scale are coreflooding exeriments conducted on rock samples (cores) extracted from reservoirs. Coreflooding experiments with computed tomography (CT) imaging are becoming common practice. They allow to investigate the sub-core scale properties such as relative permeability (k_r) and capillary pressure (P_c), and to construct multiphase flow models that not only capture the core average flow, but also the flow on the sub-core (millimeter) scale. These core flow models are important for modeling large scale models of CO_2 storage for a number of reasons. First, they allow to investigate small-scale capillary effects such as capillary trapping, which are important to reservoir scale models, particularly for estimating residual trapping. Second, they allow to relate between sub-core properties (k_r and $P_{c)}$, and overall core properties, which can then provide insight on upscaling for use in developing reservoir simulation upscaling methods. Finally, accurate coreflooding models can be applied towards forecasting, therefore replacing experiments.

In this presentation, we will discuss results of recent work on modelling both drainage and imbibition coreflooding experiments and methods for estimating properties on both core and sub-core scales. Experimental data of three-dimensional saturation distribution, capillary pressure measurements and core pressure drop will be presented. The core properties will be estimated using various different models and simulation results will be compared to the data.

Biography:

Avinoam Rabinovich obtained a B.Sc. in Geophysics and Mathematics (2007), an M.Sc. in Geophysics (2010) and a Ph.D. in Mechanical Engineering (2014) from Tel-Aviv University. He then obtained a position as a postdoctoral researcher in the department of Energy Resources Engineering at Stanford University. Since 2016 he is a faculty member at the School of Mechanical Engineering, Tel Aviv University and the head of the Subsurface Reservoir Flow Research Group. Dr. Rabinovich is interested in subsurface flows pertaining to groundwater, oil and natural gas production and CO_2 sequestration.

Reduction of the Energy Consumption in a Chemical Plant Through Industry 4.0 and the Implementation of ISO 50001

Mariano Alarcón[1]*, Fernando M. Martínez García[2] and Félix C. Gómez de León Hijes[3]

[1]University of Murcia, Campus de Espinardo, Murcia, Spain

[2]ENAE Murcia. Campus de Espinardo, Murcia, Spain

[3]Information and Communication Engineering Dept., University of Murcia, Campus de Espinardo, Murcia, Spain

Abstract

The so called Industry 4.0 is a set of tools and strategies that introduces the digital technologies to industry. In the case of a chemical industry located in Murcia (Spain) efforts focused on the development of Internet of the Things (IOT), Cloud computing, Big data and systems integration. By means of these, an almost complete monitoring of all facilities and energy consuming devices has been carried out, enabling the Energy and Maintenance Management (EMS and MMS, resp.) of the entire industry. The measurement of energy parameters, performed by network analyzers and others and their comparison with equipment set points, process parameters, provided by the Distributed Control System (DCS) through SCADAs and others, and the operating parameters, provided by the Manufacturing Execution (MES) of the plant, enable the identification of anomalous situations that even warn of predictable failures. A key action has been the implementation of the ISO 50001 standard throughout the plant in the last three years. Figure 1 shows the economic consequences of reducing energy consumption from 2009 to 2020, which has significantly dropped, despite a small increase in the last 2 years, mainly due to temporary causes, without substantial changes in the plant's equipment and processes. The cost of energy in the company's results represented in 2019 less than 50% of those of 2009. The combined action of EMS and MMS is considered the main cause of the clear reduction in energy consumption and plant availability in the last ten years.

Biography

Mariano Alarcón García is a University Professor in the area of Thermal Machines and Heat Engines at the University of Murcia, where he has been teaching since 1986 in various subjects in the field of energy engineering at all university levels. His R&D&I work has focused on optimizing heat transmission, energy efficiency and renewable energies, in particular, solar thermal energy. His h-index is currently 8 (Google Scholar).

Decentralized Wave Energy

Vitalii Semeniuk

DD Wave Energy LLC

Abstract

Our company has created a floating installation for extracting energy from coastal sea or ocean waves of low energy saturation. The key features of this installation are: variable shape of floats, use of a two-dimensional wave in the range of 180° wind direction, direct conversion of wave energy into torsional energy of the generator shaft, low capital investment (about 260 USD per 1 kW of rated power), simplified installation of the unit with the possibility of dismantling without changes in the relief of the environment. We consider that the use of a range of plants with a power in the range (10-100 kW) can be demanded by many consumers to obtain inexpensive renewable energy, especially for consumers located on the coastline of islands with ocean waves. The decentralized

placement of installations directly at the points of energy consumption provides the opportunity to replace a significant part of the final consumption, as well as an additional balancing opportunity for the energy system as a whole. The units can operate in a fully automatic mode, do not require frequent regular maintenance and are able to extract energy at a coastal wave height of 0.3m to 1.5m. The participation scope in GEM-2023 is to obtain information: on the regulatory policy in the coastal states of the USA regarding wave energy, the possibility of organizing the production and installation, developments in the field of renewable energy production dispatching, and other information that is necessary for the operation of the project. In addition, communications with consulting organizations in the field of renewable energy are interesting, including technical consulting, establishing contacts with companies that have the ability to manufacture and install line. An important goal is to establish contacts with energy companies that may be interested in including a cluster of dispersed wave energy production in their energy mix.

A presentation on our Diving Dragonfly project is potentially being considered, taking into account the receiving of the latest information about its realization.

Biography:

Semeniuk Vitalii Ivanovych, Director DD Wave Energy LLC, Chernivtsi, Ukraine. Higher education - Kyiv national university named after Shevchenko – 2008. Development of own private business, optimization of business processes, crisis management, venture financing. Since 2021, together with other projects, with a group of specialists, I have been making efforts to implement a patented method for extracting coastal wave energy, studying and implementing methods for storing and transporting energy. As of the current time, there is funding and organization of implementation in three patent areas. Communication language: Romanian, Ukrainian, Russian, English.

Parallel Session-III

Session – Environmental Energy | Waste to Energy

Advances in Multiscale Modeling: Case of Biomass Thermochemical Processes

Farid Chejne*, Juan C. Maya and Robert J. Macias

Universidad Nacional de Colombia, Colombia

Abstract

Lignocellulosic biomass is a residual of the agricultural activities became to multiple opportunities for biomass valorization. The depolymerization of these blocks is important because it is possible to obtain several chemical compounds by different pathways. There are processes for both thermochemical and biological conversion of lignocellulosic biomass to obtain industrially relevant bioproducts from waste biomass. Although there are significant advances from the experimental approach to these new technologies, the theoretical underestimating of the phenome involved in the transformations is still a challenge. In this sense, the aim of this presentation is to show the main advances in the multiscale modelling of thermochemical processes for taking advantage of biomass waste.

Biography:

Farid Chejne is a post-doctoral researcher at University Libre of Brussels (1997). He earned PhD in Energy systems at Technical University of Madrid (1991). BSc in Physic (1989) by University of Antioquia and Mechanical Engineer by University Pontificia Bolivariana (1983). From 1983 to 2002, he is a Titular full time Professor at National University of Colombia. His research interests are related to modelling and simulation of processes and analysis of energy systems. He has participated in multiple national and international research projects, and published more than 160 research papers.

Seed-spec: A Native Seed Blend Development Tool

Nicholas Demel

Bamert Seed Company, Muleshoe, TX

Abstract

Establishing native vegetation in any reclamation project can be a challenging task. The species and varieties that match the site must be identified and used to help ensure adequate establishment and persistence. Data exists to help project managers identify what species are native to a given area and which ones are commercially available, but this data can be cumbersome, not user friendly, and time consuming to use.

Bamert Seed Company has worked with Colorado State University to develop a web application to easily identify a project area of interest (AOI) and provide information on native species composition for the AOI. The tool will provide a list of commercially available species that correspond to the plants that grow natively in the AOI and intuitively walk the user through developing a site-specific native seed blend. The recommended seeding rate from NRCS will be used to calculate the pounds of pure live seed (PLS) that will be needed for the project. Users will have the ability to adjust

the seeding rate based on their establishment objectives and seeding method they will be using. Having this tool will allow the users a timely way to determine the best blend for their AOI and get the seed blend to a vendor/seed dealer with knowledge that the species selected will work for their specific site. Rob will discuss the importance of native plants and the benefits they bring to reclamation projects such as adding biodiversity and improving soil health. He will discuss and present version 1 of the tool and ask attends to provide input on what other functionality/data would be useful for their operations for version 2.

Additional Key Words: Biodiversity, Ecosystem Services, Revegetation, Reclamation, Species Selection 1. Rob W. Cook, Director of Business Development, Bamert Seed Company, Muleshoe TX 79347, George Peacock, Research Associate, Object Modeling Systems Laboratory, Colorado State University, Fort Collins CO 80523

Biography:

Nicholas grew up in the small farming community of Pep in the Texas Panhandle. He received a BBA and a MBA in Marketing from West Texas A&M University. After graduation, Nicholas spent 5 years with the Natural Resources Conservation Service consulting land managers on improving/maintaining conservation practices on lands across the Texas Panhandle. He served as a District Conservationist and a Conservation Technician with the NRCS. Currently, Nicholas is a Reclamation Specialist with Bamert Seed Company. He enjoys working with clients to ensure they achieve the best results when planting native seeds on their specific projects.

Reaction Mechanisms of Acid-catalyzed Cracking and Alkylation in the Upcycling of Polyethylene: AIMD Study

Mal-Soon Lee*

Pacific Northwest National Laboratory, Richland, WA

Abstract

Material made of plastic is ubiquitous in products ranging from packaging and textiles to medical equipment and vehicle components. However, most of the disposed plastic is accumulated in landfills and dispersed into water bodies. This engenders unprecedented attention to catalytically upgrade polyolefin waste into fuels and value-added chemicals which will be a key step toward a circular economy. However, conversion of waste polyolefins is particularly challenging due to the C(sp^3)-C(sp^3) bonds, which are more stable than the chemical bonds of functionalized polymers such as polyesters and polyamides. Moreover, despite the face that low-temperature operation would empower significant energy savings, the endothermic cleavage of the C-C bonds makes processes thermodynamically unfavorable at low temperatures. As a consequence, converting polyolefins typically requires severe reaction conditions to overcome the kinetic and thermodynamic constraints at low temperatures.

Recently, we experimentally showed that low-temperature conversion of polyethylene to liquid isoalkanes (C_6-C_{10}) at temperatures below 70 °C can be achieved by combining two catalytic approaches, i.e., acid-catalyzed cracking and alkylation of polyolefins with isoalkanes, catalyzed by a Lewis acidic chloroaluminate ionic liquid. In this talk, I am going to present our computational study of the reaction mechanisms of these reactions at the atomic scale from ab initio molecular dynamics simulations in aid of a Blue Moon ensemble method.

Biography:

Mal-Soon Lee is a senior scientist at Pacific Northwest National Laboratory, USA. She has been working in the field of computational physics/chemistry with an emphasis on studying the phase behavior, reactivity at complex interfaces, confined systems and in liquid phase. Her areas of application include catalysis, battery materials, surface science, and polymer upcycling. To understand reactivity of homo- and hetero-phase materials, large-scale high-performance computing techniques such as ab initio molecular dynamics combined with enhanced sampling techniques are employed. With obtained data, various statistical mechanics techniques are applied to calculate reaction enthalpies/entropies, spectroscopies, which can be directly compared with experimental observations.

Energy Recovery from High-Rise Building from Falling GreyWater

Gideon Oron[5,6,*] , Eden Hadad[1], Erez Fershtman[2], Zohar Gal[3] and Ido Silberman[4]

[1]Supersal company, HaRokmim St. 26, Holon, Israel

[2]Gigantic company ltd., Tvu'ot HaAretz 3, Tel Aviv, Israel

[3] Yael group, Atir Yeda St. 9, Kfar Saba, Israel

[4]NVIDIA company, Shlomo Building, HaKidma St., Yokneam Illit, Israel

[5] The Department of Industrial Engineering and Management, Israel

[6]Zuckerberg Water Research Institute, Jacob Blaustein Institutes for Desert Research,

Ben-Gurion University of the Negev, Kiryat Sde-Boker, Israel

Abstract

The growing pressure on generating green new and advanced energy resources along with the increasing demand for efficient use of the scarce water resources has stimulated the development of nonconventional alternatives. Greywater can be used for human, agriculture and green purposes however, also for environmentally friendly energy generation. Greywater is commonly disposed in the cooperative systems. Primarily in high-rise buildings the common disposal systems can be separated from the collective structure and used for energy resources generation. The idea is to install turbines at various levels of the building for energy manufacturing for immediate use and/ or temporary storage. By installing turbines in the high-rise building for local production of energy the potential energy of the falling greywater is turned into a useful power source. The greywater can subsequently be used for irrigating the adjacent agricultural and ornamental areas.

This work demonstrates applying a simulation procedure selecting the options among the many available alternatives of energy production from free-falling greywater in high-rise buildings. Although according to preliminary assessments the amount of energy produced is limited, extra work is still needed for improving the recovery systems. The taller the building - the higher is the amount of energy that can be produced.

Biography:

Gideon Oron completed his studies in the Technion, Israel Institute of technology. Currently he is in Blaustein Institutes for Desert Research of Ben-Gurion University of the Negev. He is involved in research and teaching in problems associated with energy, water agriculture and environmental issues.

Portable Mixed-Potential Sensor System for Methane Monitoring

Kamil Agi[1]*, Lok-kun Tsui[2], J. Smith[1], Sleight Halley[2], Kannan Ramaiyan[2], Robert Ian[1], Ramiro Jordan[3], Fernando Garzon[2]

[1]SensorComm Technologies, Inc., USA;

[2]University of New Mexico - Center for Micro-Engineered Materials, USA;

[3]University of New Mexico - Electrical and Computer Engineering, USA

Abstract

The energy sector is estimated to account for 40% of methane emissions from anthropogenic sources. Mitigating the environmental effects and financial costs of methane leaks **requires** continuous monitoring of natural gas (NG) infrastructure, which in turn requires development of low-cost, field-deployable systems.

Mixed-potential systems, based on ceramic electrolytes and metal (or metal-oxide) electrodes, are expected to be capable of resolving sub-components of natural gas mixtures and interferent mixes at the resolution required for buried pipeline monitoring. We have developed additively manufactured mixed-potential electrochemical devices, which are paired with sensor electronics that leverage artificial neural networks to identify and differentiate multiple sources of methane emission (anthropogenic vs. agricultural vs. wetland). This sensor system is coupled with a smart IoT platform to significantly simplify the challenge of mitigation implementation strategies.

The smart IoT platform enables recording of the sensor data and transmission to the cloud for additional processing which creates an *early-warning system* to help existing and novel mitigation approaches. The goal of the system is to leverage ML and AI, both at the edge for identification/quantification and in the cloud for additional analytics (including predictive analytics) to provide the early-warning capability.

Data gathering strategies, information extraction and development of actionable intelligence will be discussed. Results from field testing the mixed-potential sensor system outside the laboratory will also be presented.

Biography

As President-CEO of SensorComm Technologies, Dr. Agi is building a better, more sustainable world through smart IoT solutions for transportation, energy, and health. He also provides commercialization expertise to organizations including DARPA, MIT, Stanford, UNM and NSF. He is a founding member of the Peace Engineering Consortium and speaks globally on climate change, industry 4.0 and next-generation IoT. Dr. Agi received his Ph.D. in EE from the University of New Mexico, BSEE and MSEE from NYU, and his MBA from the Berkeley-Columbia Executive MBA Program. In addition, he serves as Research Associate Professor (LAT) at the University of New Mexico.

Next Generation of High-performance Thermoelectric Materials in Waste Heat Recovery and Thermal Management Applications

Bed Poudel*, Wenjie Li, Amin Nozariasbmarz, Yu Zhang, and Shashank Priya

Penn State University, University Park, PA

Abstract:

Ever-growing energy demand, escalating energy prices, and environmental concerns compel us to look for cleaner and more sustainable energy sources. There is also emerging need for on-demand production of electrical power using locally available energy sources such as waste heat. This need is driving the development of next generation of high-performance materials and generators that are compact, efficient, and cost-effective. Thermoelectric devices are solid-state power generating devices producing electricity whenever a temperature gradient is applied which can be obtained by burning the fuel, woods, natural gas, solar concentration, and wasted heat etc. The thermoelectric devices, being solid state, compact and continuous generation, can achieve very high-power density and can be scaled up or down without loss of efficiency which are advantageous compared to other power generation technologies especially in kW or lower scale generator size. Thermoelectric devices can also be used in heat pumping applications such as heating/cooling and thermal management. In this talk, I will be primarily discussing about the thermoelectric technology for power generation and thermal management. Current limitations and some strategies to overcome the performance barriers leading to new application will also be discussed.

Biography:

Bed Poudel, considered a pioneer in the field of nanostructured thermoelectric materials, has been working at Penn State University since 2018 as a Research Professor. Dr. Poudel earned his Ph.D. degree in Physics from Boston College specialized in nanostructured thermoelectrics and has almost twenty years of experience in various smart materials such as thermoelectric materials, shape memory alloys, and thermomagnetic alloys etc. and applications development. His expertise includes nanomaterial synthesis, characterization, as well as device design and manufacturing. Dr. Poudel holds over twenty patents and patents pending in the field of thermoelectrics and has published over forty-five scientific articles in various journals including Science and Nature Materials. He is also a recipient of R&D 100 award in 2008 for his work on thermoelectric materials. Prior to current role, Dr. Poudel worked in several companies focused on nanotechnology and thermoelectric power generation. At Nimbus Materials Inc, he worked as a R&D director developing flexible-thin film thermoelectric products for body powered thermoelectric generators for consumer electronics and sensors. Earlier, as director of R&D and CTO at Evident Technologies, he led the technical team in developing high temperature thermoelectric materials and devices and launching thermoelectric generator products. Dr. Poudel also worked at GMZ Energy in various roles including R&D director from 2007 to 2013 developing thermoelectric materials and products such as solar thermoelectric generator.

Suitability Studies on Appropriate Waste to Energy Technologies for Infectious Waste and e-waste in the Global South: A Philippine Case Study

Reynald Ferdinand Manegdeg, Analiza Rollon, Florencio Ballesteros, Jr., Eduardo Magdaluyo, Jr., Louernie De Sales-Papa*, Eligia Clemente, Emma Macapinlac , Roderaid Ibañez , Rinlee Butch Cervera Dominador A. Eusebio[5] , David P. Lim

University of the Philippines Diliman, Quezon City, Philippines

Abstract

Seven waste to energy technologies were considered in this study including: Anaerobic Digestion, Conventional (Grate) Incineration, Fluidized Bed Incineration, Gasification, Conventional Pyrolysis, Plasma Pyrolysis, and Microwave-Induced Pyrolysis. The assessment process was carried out using a multi-attribute decision analysis method to select the appropriate infectious waste and e-waste in Metro Manila, Philippines. The attributes for the assessment includes overall efficiency, waste reduction rate, maximum capacity, reliability, lifespan, energy conversion cost, and environmental

emissions. The initial screening from this process were then ranked according to efficiency, cost, footprint, work ratio, emissions, and complexity. The study has demonstrated the feasibility of setting up a WTE plant for the treatment and disposal of residual wastes in Metropolitan Manila. The pyrolysis-Brayton plant was found to be the most suitable WtE plant for the identified residual waste. A significant advantage of this technology was its flexibility and small footprint to accommodate wastes from a multitude of geographically distant locations. Moreover, installing 1-3 tpd plants in clustered locations reduces significantly transportation costs. Keywords: Waste-to-energy, Energy analysis, Multi-attribute decision analysis, Infectious wastes, e-waste, pyrolysis-Brayton plant

Coupling Gasification and Electrolysis with Methanation for Improved Production of Biomethane

Paulo Brito*, Luís Calado, Roberta Panizio, Catarina Nobre

VALORIZA – Research Centre for Endogenous Resource Valorization, Polytechnic Institute of Portalegre, Portugal.

Abstract

The production of organic waste worldwide has been growing exponentially, resulting in an increase in the number of landfills and incinerators. Overall, poor waste management practices are leading to global environmental, social and health problems. As such, the need to create and adopt sustainable closed-loop systems for waste reduction and recovery, and the production of value-added biofuels is critical. A promising solution is to use organic waste as a feedstock for gasification coupled with electrolysis and methanation systems. This system integration will produce biomethane, thus reducing waste mass by up to 85-95 %. The present work intends to implement a unit to produce biomethane from the organic wastes, based on thermal gasification and subsequent syngas methanation. The main idea is to use oxygen from the electrolysis process as the gasifying agent, obtaining a syngas with significant concentrations of hydrogen and carbon monoxide. After cleaning, this syngas goes on to the methanation process, that will use the hydrogen produced via electrolysis. After a last conditioning step, the biomethane is stored for use in mobility, particularly heavy-duty vehicles. This technology can demonstrate the global potential of circular economy based on the local production of biomethane and on-site use through the recovery of endogenous resources (wastes). This approach shows very high interest given the need to expand the production of biomethane to other technological solutions. In the end, the produced biomethane, bedides mobility applications, can generate clean, renewable heat or electricity.

Biography

Paulo Brito has a degree in Chemical Engineering (IST, Portugal), a MSc in Corrosion Science and Engineering (UMIST, UK), an MBA (INDEGISCTE) and a PhD in Chemical Engineering focused on Electrochemistry (IST, Portugal). He is a Coordinating Professor with Tenure and Aggregation at IPPortalegre's Technology and Management School (ESTG), and coordinates VALORIZA (Research Center for Endogenous Resource Valorization). His main research interests are related with bioenergy, waste management and thermochemical valorization, materials' corrosion, galvanic energy production, and production of renewable gases (hydrogen and methane) from thermochemical processes. He has published more than 200 works in papers, books, and proceedings (http://orcid.org/0000-0002-2581-4460).

Hydrocarbon Diesel Fuel from Waste

Lawrence M. Pratt

Medgar Evers College of the City University of New York, Brooklyn, NY

Abstract

Using waste plastics, waste oils and oil sludges, and other waste materials for fuel precursors diverts those materials from landfills. Many of those products originated from petroleum and as such, are technically not biofuels. They do, however, enable a second use of the same petroleum molecules as fuels after their useful lives as plastics and lubricants have ended.

In this presentation we will review our prior work on preparation of hydrocarbon diesel from brown grease, a byproduct of the sewage treatment process. Next, our efforts to produce good quality diesel and other fuels from hydrocarbon plastics (LDPE, HDPE, and polypropylene) will be described, both as an uncatalyzed pyrolysis reaction as well as pyrolysis in the presence of a zeolite catalyst. Finally, our progress in recovering hydrocarbons from fuel oil sludge and dirty fuel oil will be described.

Axisymmetric Modeling of Diesel Particulate Filter Heat Exchangers

Charles E. Sprouse III*

Benedictine College, Atchison, KS

Abstract

Diesel particulate filters are standard aftertreatment devices on compression-ignition engines across the automotive, shipping, and stationary power industries, with demonstrated efficiencies around 99%. A novel variation on the traditional diesel particulate filter geometry is the diesel particulate filter heat exchanger, which recovers thermal energy via heat transfer from the exterior of a number of smaller diesel particulate filter cores. This thermal energy is then available for secondary purposes, such as additional power generation with an organic Rankine cycle. Modeling of these devices in MATLAB using an axisymmetric core model produces a low computational burden model capable of real-time simulation using on-board computers. With this architecture, not only can tracking of a soot cake layer occur, but also thermal runaway regeneration events can be prevented through additional waste heat recovery to organic Rankine cycle working fluid, acting as a thermal mass. Across the standard operating conditions of a small diesel engine, the axisymmetric model provides accuracies on the order of magnitude of the ratio of the channel characteristic length to the diesel particulate filter core size. Through waste heat recovery, engine efficiency improvements of 8.5-13.6% are possible across the loading conditions simulated, with additional gains occurring during periodic regeneration events. This work demonstrates the ability to simulate diesel particulate filter heat exchangers to realize engine efficiency gains, and to manage soot cake layer thickness, avoiding some of the difficulties associated with early diesel particulate filter devices.

Biography:

Charles Sprouse III is an Associate Professor of Engineering in the Benedictine College School of Engineering. Before joining the academy, he worked in consulting engineering and automotive research. Specializing in power generation and emissions abatement strategies, he advances environmental stewardship through computational modeling of thermofluid systems.

Energy Recycling in Computation

Gregory L. Snider[1]*, Rene Celis-Cordova[1], Alexei O. Orlov[1], John A. Varkey[1], Jon H.M. Cowart III[1], James M. Venditto[1], Bridget A. Goodwine[1], Tian Lu[2], and Jason M. Kulick[2]

[1]University of Notre Dame, USA

[2]Indiana Integrated

Abstract

Power dissipation is the greatest challenge to computation, with the power requirements of data centers now representing a significant portion of the planet's total energy needs. The inescapable issue is the energy cost of information. Claude Shannon showed that an energy of greater than $k_B T$ ln(2) is needed to create a bit of information that is distinguishable from noise. For general purpose computation the energy used to create bits is orders of magnitude greater than this limit. While energy can be saved by encoding information with less energy and accepting the increased error rate, such as the pattern recognition at which artificial intelligence excels, many applications require both precision and accuracy. These requirements mean that information must be represented by many bits each having an energy many times the Shannon limit. Manipulating these high-energy packets of information in a computation can lead to a high dissipation if the computation is not extremely efficient. The problem is that conventional CMOS logic is extremely inefficient since the entire energy content of every bit is dissipated to heat at every logic transition. An alternative is to use adiabatic reversible computing where the energy content of information is recovered and recycled. The design of a 16-bit adiabatic reversible microprocessor will be presented that can reduce the energy dissipation by one to two orders of magnitude.

Biography:

Gregory L. Snider received his Ph.D. in Electrical Engineering from the University of California, Santa Barbara, in 1991. He has been at the University of Notre Dame since 1994, and currently holds the position of Professor and Chair in the Department of Electrical Engineering. He has authored or co-authored over 120 journal papers, and over 160 conference presentations. He currently serves as an Associate Editor for IEEE Transactions on Electronic Devices, and is a Fellow of the IEEE.

Photocatalytic Reduction of NOx. How Far we are from the Application in Real-condition Processes?

Janusz A. Lasek[1]*, Krzysztof Głód[1], Jeffrey Chi-Sheng Wu[2]

[1]Institute of Energy and Fuel Processing Technology, Poland

[2]Department of Chemical Engineering, National Taiwan University, Taiwan

Abstract

There are three ways of photocatalytic removal of NO_x: (i) photo-selective catalytic reduction (photo-SCR), (ii) photo-oxidation, and (iii) photo-decomposition. The photo-oxidation of NO_x will lead to nitric acid formation, which must be removed from the photocatalyst surface. Nevertheless, this process is commercially available, as for example photocatalytic purification surfaces (concrete, cements, coatings, paints). Photo-SCR is promising technology that relies on the transformation of NO_x into N_2 and other harmless compounds. Nevertheless, as far as we know, this technology has been not commercialized yet. In this presentation, the state-of-the-art of photo-SCR are is presented. It is explained how the photo-SCR at presence of the oxidative compounds like H_2O

ABSTRACTS

and O_2 is possible and what is the role of temperature in photo-SCR (so-called photo-thermo-SCR). The results of photo-thermo-SCR processes, realized in lab- and pilot-scale photo-reactors, are presented and discussed. Finally, the possible applications of photo-thermo-SCR in real condition processes (flue gas and air) are analyzed.

Biography:

Janusz Lasek was born in Katowice (Nikiszowiec), Poland in 1979. **Education**: **M.Sc.** (2004) and **Ph.D.** (2009) Silesian University of Technology, **post-doc** (2009-2010) National Taiwan University, **Habilitation** (D. Sc. 2020) Silesian University of Technology. Currently, he is working in the Institute of Energy and Fuel Processing Technology, Zabrze, Poland as an **Associate Professor**.

Production of SRF from Municipal Wastewater Plants Screening Waste: A New Approach Towards Zero Waste

Montserrat Zamorano Toro[1]*, Juan Jesús de la Torre Bayo[1], Jaime Martín Pascual[1], Juan Carlos Torres Rojo[2]

[1]Department of Civil Engineering. University of Granada. Spain.

[2]EMASAGRA. Granada, Spain.

Abstract

A new approach in the operation of wastewater treatment plants is addressed to redefine them as biorefineries which operate according to circular economy principles. In this direction, screening waste from a municipal wastewater treatment plant located in Granada (Spain) has been used to produce densified and not densified solid recovered fuel (SRF). Taking into account guidelines about SRF quality and applications, results have shown the possibility to produce fuel, according to lower calorific value (PCI), chlorine content and mercury content recommendations. Besides, pellets production variables have been optimized to produce pellets with suitable mechanical parameters such as apparent density, hardness and durability, in line with quality regulations and quality of pellet conditioning. It has been possible to conclude that it is feasible the production of SRF from wastewater treatment plants screening waste, contributing to the achievement of Zero Waste in the wastewater treatment processes and aiming to valorize 100% of the residues generated.

Biography:

A total of 15 PhD supervised, 9 of them with international mention, 13 awarded Cum laude and 3 awarded with extraordinary prizes. Research field in environmental technologies, including topics as energy from waste. According to Scopus, there are 101 international publications, a total of 2588 citations in 2261 documents, of which 1601 are from the last 5 years (2018-2022); These data imply an h-index of 29. Professional career recognized on February 28, 2020 with the award of the Andalusian Medal for Environmental Merit awarded by the Ministry of the Presidency, Public Administration and the Interior of Andalusia Government (Decree 41/2020).

A Methodological Framework to Develop Adaptation and Mitigation Climate Strategies Together Including Participatory Process: Distener EU Project

Roberto San José * and Juan L. Pérez-Camaño

Environmental Software and Modelling Group, Computer Science School, Technical University of Madrid (UPM), Spain

Abstract

Holistic approaches to mitigation and adaptation must be tailored to the context-specific situation and this requires a flexible and participatory planning process to ensure legitimate and salient action, carried out by all important stakeholders. DISTENDER is an EU-funded 42-month project to develop a methodological framework that guide the integration of climate change (CC) adaptation and mitigation strategies through participatory approaches in ways that respond to the impacts and risks of CC, supported by quantitative and qualitative analysis that facilitates the understanding of interactions, synergies and trade-offs. DISTENDER will develop a set of multi-driver qualitative and quantitative socio-economic-climate scenarios through a facilitated participatory process that integrates bottom-up knowledge and locally-relevant drivers with top-down information from the global climate models and European Shared Socioeconomic Pathways. The economic impact of the different efforts will be analyse, including damage claim settlement and how do sectoral activity patterns change under various scenarios considering indirect and cascading effects. DISTENDER will follow a pragmatic approach applying methodologies and toolkits across six Case Studies of national, regional and urban scale: Austria, Northeast of The Netherland, South-West Iberian Peninsula, Guimaraes, Gdansk and Metropolitan City of Turin and five additional Follower Case Studies are first in line for replication. The knowledge generated by DISTENDER will be offered by a Decision Support System (DSS) which will help policy makers to take the most out of the knowledge, tools and recommendations generated by DISTENDER and further replicate them.

Biography:

Roberto San Jose completed his PhD in 1982 related to the unstable surface turbulent boundary layer parameterisation. He has been involved in air pollution modelling mainly using three dimensional mesoscale models, such as MM5 and CMAQ. He created the Environmental Software and Modelling Group at Computer Science School of the Technical University of Madrid (UPM) in 1992. He spent one year at the Max-Planck Institute for Meteorology and two years at IBM-Bergen Environmental Sciences and Solution Centre. He has more than 150 publications in different national and international scientific journals. He has been a Full Professor since 2001.

Trend of Sulphur Dioxide Emissions and Concentrations in Ontario, Canada during 1991-2019

Xiaohong Xu* and Tianchu Zhang

University of Windsor, Canada

Abstract

To combat the adverse impact of sulphur dioxide (SO_2) pollution on the environment and human health, the Ontario (Canada) government has implemented several measures, including control orders for Ontario smelters, Countdown Acid Rain program and Canada-wide Acid Rain Strategy, Ontario emissions trading regulations on sulphur dioxide (O. Reg. 397/01), cessation of coal fired power plants, and low sulphur content in transportation fuels. Since 2014 Ontario has completely phased out its coal powered generators, the first in North America. However, there are mixed opinions toward the cessation of coal fired power plants. Some worried that nuclear and combustion of other types of fuel will fill in the gap in the power demands of Ontario, instead of renewable energy. Some argued that there may not be a substantial improvement in the air quality of the

province because of regional and transboundary transport of air pollutants. Others believed that the reduced SO_2 emission came with a financial burden for the people of Ontario. In this study, the trends of SO_2 emissions and concentrations in Ontario during 1991-2019 was assessed and the impact of phasing out coal fired power plants on emissions and air quality was investigated.

Biography:

Xiaohong Xu is a professor in the Department of Civil and Environmental Engineering, University of Windsor, Canada. She obtained her PhD degree in Environmental Engineering at the University of Connecticut, USA. Her research interests include air quality monitoring and modeling; emission, transport, transformation, and fate of air pollutants; source apportionment; spatial/temporal trend of air quality; emission control; exposure and risk assessment.

A Contribution of Petroleum Energy System in Brazil to the Climate Change Mitigation

José Maria Alves Godoi

Paleon Energy, Brazil

Abstract

The work develops on the Brazilian energy matrix together with the fossil fuels and GHG increasing within it; mentions the large CO2 emissions by means of O&G extraction inside the Pre-salt at country and the advanced practices used to miscible CO2-EOR with carbon geosequestration in that petroleum province. It will also discuss about the latent and broad national carbon capture, utilization, and storage (CCUS) market in the electricity generation system based on natural gas, with its relevant outcomes of new technologies achievement, investments and so on. Global CCUS along with CO2-EOR together with other methods of storage has a new and decisive role on the global CO2 reduction and it has reached a tipping point of continuous increasing of new projects worldwide. In the sustainable development scenario, in total, CCUS contributes nearly 15% of the cumulative reduction in CO_2 emissions globally compared with the Stated Policies Scenario. The challenge proposed to the United Nations of 1.5°C as climate change target set out in the Paris agreement, net-zero emissions globally by 2050, additionally validates the need to rise substantially the number of CCUS projects to help offset emissions from fossil fuels used by countless economies around the world. In Brazil, nowadays, for example, Petrobras has a program of geological storage to reach about 40 Mtpa of CO2 within the petroleum pools by 2025. Alongside energy efficiency and renewable, CCS/CCUS represents a way for energy transition. The work still demonstrates the CO2/CCUS market, which comes from the electricity generation based on the natural gas thermoelectric power plants and reaches up to 353.83 Mt CO2, as a result from the captured and removed CO2 from atmosphere, to be stored within the oil/gas reservoirs by means of CO2-EOR, (inside the petroleum energy system), onshore and offshore. This market is defined over the considered eight years period. Thus, this paper concludes by the evidence of this amount of CO2 geosequestration that the petroleum energy system in Brazil has a significant contribution to the climate change mitigation, providing scientific information with novel developments among engineers, researchers and investors in the country.

High-Temperature Metal Chemistry for Climate Mitigation

Adam C. Powell, IV*

Worcester Polytechnic Institute, Worcester, MA

Abstract

Deployment of today's technologies for solar and wind generation, battery storage, and electrification of transportation and heating can go a long way toward decarbonization of our energy system. But there are persistent challenges in several areas, particularly industrial metal production, long-distance shipping and aerospace, long-term electrical energy storage, and bioenergy with carbon capture, which require new solutions.

High-temperature metal chemistry holds several potential new solutions. Several benefits are clear: electrons are cleaner energy carriers and chemical agents than carbon or hydrocarbons; at high temperature, fast reaction kinetics lead to process intensification; and molten oxyhalide electrolytes are made out of charge carriers and can support very high current density.

This talk will present multiple new high-temperature metal chemistry and electrochemistry concepts which could help solve the most challenging decarbonization problems. Electrolytic metal production with an inert anode can produce silicon for solar energy, rare earths for wind turbines and electric vehicles, and light metals magnesium and aluminum, at low cost with zero direct emissions. A new distillation process can recycle magnesium metal, lead from batteries, and rare earth magnets. A new molten salt magnesium-air battery can power ships or aircraft across oceans. A liquid metal anode direct carbon fuel cell generates negative emissions bioenergy with carbon capture at high efficiency with a simple flowsheet. And a new aviation fuel absorbs greenhouse gases and other pollutants from the atmosphere. This technical overview will be followed by a brief description of risk mitigation and deployment methodology.

Biography:

Adam C. Powell, IV is an Associate Professor in the Mechanical & Materials Engineering department who joined WPI in August 2018. Within materials processing, he focuses on new technologies for greenhouse gas emissions reduction, elimination, and drawdown. Current projects aim to reduce vehicle body weight, lower solar cell manufacturing energy use and cost with improved safety, reduce or reverse aviation greenhouse emissions, power ships and trains with zero emissions, and improve grid stability as we drive toward 100% renewables. The primary tools for achieving these goals are customer discovery to ensure relevant focus, mathematical modeling, and validation by key experiments.

Addressing Grid Resilience in a Changing Climate: From Renewable Energy Drought to Power Outage Prediction and Restoration Modeling

Diego Cerrai*

University of Connecticut, USA

Abstract

Climate change is bringing an intensification of severe weather events, which are increasingly impacting our infrastructures and our lives. While electric power systems across the globe are impacted by these events, they are also transitioning from being powered by traditional energy sources to being supported by renewable energy sources. In this framework, it is necessary to understand what the resilience of current and future electric systems is to weather and climate threats. In this presentation, I will discuss the challenges that the future, renewable-powered, electric grid in the U.S. ISO-New England area will face when affected by extreme weather events.

I will highlight periods of energy drought and curtailment, to pinpoint criticalities and propose solutions to the contrast the increased variability of the energy generation landscape. Moreover, I will present power outage prediction models capable of predicting impacts of different types of storms on the electric grid in terms of expected amount and location of damage, and outage restoration models, capable of predicting the estimated restoration times after the impacts of such events.

Biography:

Prof. Diego Cerrai is Assistant Professor at the Department of Civil and Environmental Engineering at the University of Connecticut (UConn). He is also Associate Director for Storm Preparedness and Emergency Response, and Manager of the UConn's Eversource Energy Center. Dr. Cerrai's main research focuses on understanding and improving the predictability of the impact of severe weather events on the electric grid in a changing climate, both in terms of power outages and power generation/consumption. Moreover, he is developing models for improving storm outage restoration, and performing fundamental research aimed at improving the measurement and predictability of meteorological variables during storms.

Perspectives on the Future of Nuclear Energy in Slovakia

Branislav Vrban*, Vladimír Nečas, Jakub Lüley, Štefan Čerba

Slovak University of Technology in Slovakia, Slovakia

Abstract

The Slovak market for electric power generation is small compared to that of other European countries. Anyhow quite a unique mix of energy sources, a small number of inhabitants, and a well-developed nuclear industry make the story of Slovakia interesting and worth knowing. The status of new builds and decommissioning activities will be given with the following brief presentation of the Slovak University of Technology in Bratislava with a focus on the Institute of Nuclear and Physical Engineering. The last part of the contribution will be devoted to the new platform for education in nuclear being established in Central Europe. European Nuclear Experimental Educational platform aiming to simplify access to research reactors and specialized laboratories for students and researchers will be introduced and discussed.

Biography:

Branislav Vrban graduated from the Slovak University of Technology in Bratislava, Slovakia in 2011. He is an associate professor and serves as a deputy head of the Institute on Nuclear and Physical Engineering of the same university. His research and lecturing are focused on reactor physics, radiation shielding, and decommissioning of NPPs. He is active in several national and international R&D projects and serves as an expert advisor to the Nuclear Regulatory Authority of Slovakia

An Efficient Energy Planning Under Net-zero Emission Policies Considering Multi-aspect of Requirements

Sudlop Ratanakuakangwan* and Hiroshi Morita

Graduate School of Information Science and Technology, Osaka University, Japan

Abstract

Energy transitions around the world are in the present context of net-zero emissions. However,

the environmental sustainability should not be solely focused on, but broader requirements are needed to be considered. The purpose of research is to propose a framework determining the most efficient energy policies that aim for the net-zero emission in energy planning. The efficiency is defined as an ability to meet multiple aspects of requirement of energy planning, including energy, economic, environmental, employment, security and social. Slack-based measure model is implemented to measure energy efficiency. The proposed model and its empirical results can effectively be implemented as a quantitative support for policy makers in long-term energy planning. Biography: I am a specially appointed researcher at Graduate School of Information Science and Technology, Osaka university where I earned my Ph.D. My main research interests are efficiency measurement, stochastic optimization, robust optimization, and energy planning. During PhD until now, I have published a number of manuscripts, for instance "Energy efficiency of power plants meeting multiple requirements and comparative study of different carbon tax scenarios in Thailand" at Cleaner Engineering and Technology, "Hybrid stochastic robust optimization and robust optimization for energy planning – A social impact-constrained case study" and "Multi-aspect efficiency measurement of multi-objective energy planning model dealing with uncertainties" at Applied Energy.

Contribution of Economic Growth to Circular Economy Development and CO2 Emission Reduction

Chung-Huang Huang[1] *, Hung-Yi Chu[2] , and Jian-Fa Li[3]

[1]ECO Group/Greater China Financial and Economic Development Association, Taiwan

[2]Eco Technology & Consultants Co., Ltd, Taipei City, Taiwan

[3]Chaoyang University of Technology, Taiwan

Abstract

Since the adoption of Kyoto Protocol in 1997, Taiwanese government had organized five Nation Forum on Energy, focusing on the linkage between economic growth and environment. In light of the positive correlation between CO2 emission and economic growth rate, environmental groups used to attribute the environmental degradation to the historical pathway of economic growth. Most of the empirical findings from such methods as Kaya Identity, Environmental Kuznets Curve (EKC) as well as IO model indicated that environmental decoupling is rather unlikely (see Parrique et al., 2019, for instance) and lends positive support to the Degrowth hypothesis. While Kaya Identity approach is embedded with certain disadvantages (Huang, 2013) and EKC subjected to various econometric problems (Stern, 2004), the linkage between economic growth and environment deserves reexamination particularly when 'Good job and economic growth' is identified as one of the elements in the 2030 Sustainable Development Goals (SDGs). Considering the properties of data being used, we developed two ARDL models, one for evaluating the contribution of circular economy development to GDP growth and the other for validating the contribution of GDP per capita to CO2 emission. Unlike the conventional regression models, the cointegration regression reveals that a positive linkage between circular economy development and GDP growth in the long-run equilibrium, while the ECM indicates that the positive linkage might be reversed for some indicators in the short-run dynamics. Furthermore, GDP growth is found to contribute positively to CO2 emission reduction, even though EKC is not significantly downward sloping.

Biography:

Huang received his Ph.D. in 1986 from the Department of Applied Economics at University of Minnesota, and then started his career as a professor at National Tsing Hua University (NTHU) in Taiwan. Immediately after his early retirement from NTHU in 2010, he joined Taiwan Research

Institute as the Vice President in 2011, acted as the President of Taiwan Association of Environmental and Resource Economics in 2016, and now the President of the Greater China Financial and Economic Development Association.

Ending Gas – The UK's Path to a Net-zero Built Environment

Aaron Gillich

BSRIA LSBU Net Zero Building Centre, UK

Abstract

This talk focuses on how the UK can decarbonise the built environment as part of the pathway towards a net zero economy by 2050. Over a half century of investment in gas infrastructure has made the UK uniquely dependent on gas as the backbone of their energy system. More than any other European country, the UK is almost exclusively reliant on gas for space heating and hot water needs. Ending the use of gas in its current form is the UK's greatest policy and technical challenge in delivering a net zero future and limiting climate change to 1.5˚C.

Among a range of options to replace gas for heating, two of the most discussed are heat pumps and hydrogen. Neither can replace gas alone and both face challenges in principle and in practice. In principle, heat pumps are the most efficient and scalable but in practice the supply chains lag behind other nations. Many decision makers await hydrogen, but this is a decade away and faces significant cost and safety challenges. Pilot programs for heat pumps, hydrogen, and a range of other options are underway across the UK. This presentation will analyse a selection of case study examples and compare them based on cost and scalability. It will put these case studies in the context of the national decarbonisation strategies and discuss the feasibility and speed for ending gas in the UK.

Biography:

Aaron Gillich is Professor of Building Decarbonisation and Director of the BSRIA LSBU Net Zero Building Centre. The Centre is a joint venture between BSRIA and LSBU with the goal of accelerating a decade of action on decarbonising the built environment. Aaron has worked for the past 15 years across industry, academia, and government. His research centres on the links between technical and policy solutions to decarbonising existing buildings. He has led a number of research and demonstration projects for low carbon innovations in heat pumps and heat networks. His interests also include retrofit programme design and market transformation strategy.

Transformative Innovation Policies in Cleantech and Their Impacts on Innovation and Profitability

Amirsalar Jafari Gorizi*, Anna Fung

American University, USA

Abstract

The rise of cleantech companies may be a response to changing environmental forces. Many of these companies aim to increase sustainability in their operations with so-called transformative innovation policies. While much of the current literature has been focused on the tradeoffs between sustainability and profitability in different sectors, the role of transformative innovation policies on innovation and financial performance has been usually neglected. In this study, we

aim to assess the impact of non-market factors (such as peer influences, regulatory prompts, and political spectrum) on companies' abilities to create transformative innovation policies and to see how such policies impact the innovation and profitability of companies across the cleantech industry in the United States.

Biography:

Amirsalar Jafari Gorizi is a graduate student at Kogod School of Business at American University, Washington, DC. He holds a Master of Art in Information Technology and has completed his undergraduate in Business Administration. He studies Sustainability Management and he is a research and teaching assistant at Kogod. His main research areas are Ecologically Sustainable and Socially Responsible innovations in business models. His research has been published in Sustainable Cities and Society, Sustainability, and World Review of Science Technology and Sustainable Development. He has presented his works at conferences across the United States.

Automated Box-Jenkins Methodology to Forecast the Prices of Crude Oil and Its Derivatives

Metin Turkay[1*], Ahmet Can Serfidan[2], Gurkan Ozkan[2]

[1]Koc University, Istanbul, Turkiye

[2]TUPRAS, Turkiye

Abstract

Refineries are continuous-flow manufacturing facilities that have considerable effect on national economy. In very short terms, petroleum refineries can be summarized as processing crude oil to more valuable product by making use of chemical and physical operations. Production planning and process scheduling are among of the most important activities of refineries for maximizing the profit. There are several software packages to optimize the refinery operations; these tools need a variety of data such as prices of feedstock and products, demands for all of the products and byproducts and supply limits. Since the usual planning period covers the next two months, forecasting the future prices of products is very critical.

Developing forecasting models that incorporate that external parameters in addition to past data for crude oil and derivatives is a challenging task since it is highly depended on economical, geographical and political issues. However, forecasting the prices is very important for strategic planning and operational decisions in oil refineries. This paper presents an automated tool to predict prices of crude oil and its main products by applying Box-Jenkins methodology for the next two months at the beginning of each month in a rolling horizon manner. The resulting forecast are shared with related departments in so that the refineries develop their production plans accordingly. We show that improved accuracy with this forecasting approach is very useful in any planning and decision- making process and increases the profit.

Biography:

Metin Turkay is a Professor and Head of the Department of Industrial Engineering at Koc University, Istanbul, Turkey. He holds a PhD from Carnegie Mellon University (1996) and MS (1991) and BS degrees (1989) from Middle East Technical University. His research focuses on optimizations theory, mixed-integer programming, and development of novel solution algorithms for mixed-integer programming problems and machine learning. He is applying these theoretical developments on energy planning, sustainable energy, sustainable supply chain management and logistics, design of transportation system with special emphasis on sustainable supply chains and systems biology.

Higher Dimensional Short-time Fourier Analysis to Evaluate Cyclic Relation Evolution between Energy Investment and Macroeconomic Indicators

Soumya Basu*, Keiichi Ishihara

Kyoto University, Japan

Abstract

Apart from technological limitations, renewable energy (RE) suffers from unstable investment patterns, and market risks, which further hinders deployment of RE at large scales. Time-domain analysis of noisy signals (like stock prices) doesn't reveal useful information for policy-making. A frequency-domain (like Fourier) transformation of time series helps identifying key components in the series. Existing research show co-movements between RE and non-renewable energy (NRE) stocks, primarily applying wavelet coherence approaches to reveal the two-dimensional frequency coherence, over time [1-3]. Market investment doesn't exist in isolation, but depends on money availability and then investor propensity, which is influenced by macroeconomics. While results show short-run co-movement between renewable and non-renewable investments [1], decoupling aspects [1,2] and cross-country lead and lags [3], they fail to explain the underlying macroeconomic phenomenon causing these cyclic relationships. To fully understand the mechanism of convergence or divergence of RE and NRE investment, a third dimension (macro-indicator) needs to be revealed that differentially impacts the two.

Our study focuses on establishing co-movements among three indicators (RE, NRE stocks and an economic variable), in India (case-study) over a ten-year period. Coherence is a projection of a time-frequency transform of two signals in a single gaussian plane, which won't reveal three variable interactions. To overcome this limitation, we test the frequency-magnitude (short-time-Fourier-transform) interaction of the three indicators in a three-dimensional space, and observe the evolution of these interactions in a fourth dimension of time. We expect to reveal key indicators that guide RE/NRE investment differentially for future energy-finance-planning policies.

Biography:

Soumya Basu, from India, is a PhD scholar at Kyoto University Japan, specializing in Energy economics, specifically in feedback relationship analysis among Energy and Economics. He possesses skills in simulation and scenario testing for future energy development, via various programming interfaces. He has been a Panasonic scholar and is current a Japan Science and Technology Agency (JST) scholar, with publications in eminent journals. He has a background in Electrical Engineering from India, and has worked as a patent attorney for four years, specializing in communication and battery technology patents. He is curious about physics, and enjoys cooking, and drinking beer.

Community Energy and Sustainable Energy Transitions in East Africa: Thinking Strategically About Policy Impact: Ethiopian Case

Amare Assefa

Addis Ababa University, Ethiopia

Abstract

The Eastern Africa region is well-endowed with renewable energy resources that can meet the regional energy needs. However, the region, particularly Ethiopia, Malawi and Mozambique have the largest deficits in access to electricity. In countries facing such significant gaps in energy

access, the rapid adoption of technically feasible, economically favourable and environmentally benign renewable energy may help to deliver access to energy sustainably. Even though, the transition from the dominant use of traditional fuels to modern renewable technologies is possible, technology alone will not solve the challenge of energy access. Nowadays, new models of energy delivery are being developed by involving communities in the design and management of off-grid systems. Community energy systems (CESs) can provide additional capacity to existing grids, provide off-grid services where the grid is absent, and bridge on-grid and off-grid systems. This study provides overview of the energy access on three East African countries of Ethiopia, Malawi and Mozambique where it is believed that CESs will have important role in fostering the sustainable transition paths. In light of this, the study aims to assess the national energy policy and future directions in integrating CESs in strategic energy planning and sustainable development in the context of Ethiopia. In order to assess these issues, a survey which involved key stakeholders of the energy sector was conducted. The result of the study could be important as input for making policy-adjustments and/or revamping implementation strategies.

Structure and Energy Storage Properties of Lithium-Cation Endohedral [C60] Fullerene Salt

Eunsang Kwon[1]*, Takeshi Matsukawa[2], Akinori Hoshikawa[2], Toru Ishigaki[2], Rikizo Hatakeyama[3], Kazuhiko Kawachi[4], Yasuhiko Kasama[4]

[1]Research and Analytical Center for Giant Molecules, Graduate School of Science, Tohoku University, Sendai, Japan;

[2]Frontier Research Center for Applied Atomic Sciences, Ibaraki University, Ibaraki, Japan

[3]New Industry Creation Hatchery Center, Tohoku University, Japan;

[4]Idea International Co., Ltd., Sendai, Japan

Abstract

Since the synthesis and characterization of lithium cation endohedral metallofullerene ($Li^+@C_{60}$),[1)] several investigations have been performed on the application of $Li^+@C_{60}$ to the functional materials.[2)] The essential structural features of $Li^+@C_{60}$ would be as having lithium cation inside the spherical empty space of C_{60} fullerene. However, due to the low electron density related to the positional and dynamic disorder of the Li^+, previous researches were faced the limitations of the detailed information of the Li^+ position. In the present work, we investigated the structure of $Li^+@C_{60}$ using powder neutron diffraction at low temperature (3.7 K). Moreover, we studied the energy storage characteristics of $Li^+@C_{60}$ capacitor.

The use of neutron diffraction allowed us to determine precise and accurate the Li^+ positions. The Li^+ shows disorder over two positions with a refined occupancies of g = 0.5 and (1-g) = 0.5. The distance from the center of benzene to the Li^+ was 1.279 Å. The energy stored by $Li^+@C_{60}$/*o*-dichlorobenzene capacitor was greater by several times than that stored by TBA^+/*o*-dichlorobenzene capacitor under the same conditions. Furthermore, the charging speed of $Li^+@C_{60}$/*o*-dichlorobenzene capacitor was faster than that of TBA^+/*o*-dichlorobenzene capacitor. This would originate from the shape of $Li^+@C_{60}$ ion having a spherical structure.

1) Aoyagi, S. et al.; *Nature Chemistry* 2012, 2, 678, 2) For recent reports, see: K. Ohkubo et al.; *Chem. Commun.*, 2013, 49, 7376, E. Kwon et al.; *Chemical Physics Letters*, 2020, 801, 139678.

Biography:

Eunsang Kwon is an associate professor at Graduate School of Science, Tohoku University, japan. He received his Dr. degree in science from Tohoku University in 2001. He was a post-doctoral fellow at RIKEN Frontier Research System from 2001 to 2005, and he served as a research fellow of Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, in 2005-2008. He started his independent career as an Assistant Professor at Research and Analytical Center for Giant Molecules at the Tohoku University in 2008, and he was promoted to Associate Professor in 2015. His research interests include theoretical/computational chemistry, structures and properties of nanoscale functional materials based on endohedral metallofullerenes and their applications.

Conductive 2D Metal-Organic Framework for High-Performance Cathodes in Aqueous Rechargeable Zinc Batteries

Kwan Woo Nam[1]*

[1]Ewha Womans University, Republic of Korea

Abstract

Aqueous rechargeable zinc batteries (ARZBs), however, still linger at the research stage, requiring cathode materials with enhanced performance. The main challenge in developing the cathode materials of divalent batteries is associated with the dual positive charge that induces stronger electrostatic interactions with the host framework, impeding the diffusion of divalent ions. The presence of these positively charged metal ions also imposes a higher dehydration energy penalty when divalent ions pass through the electrodeelectrolyte interface, constituting an additional barrier in the overall cell operation. In this talk, I will introduce the development background and reaction mechanism of conductive 2D metalorganic framework (MOF). Cu3(HHTP)2, a 2D MOF with large one-dimensional channels, as a zinc battery cathode. Owing to its unique structure, hydrated Zn2+ ions which are inserted directly into the host structure, Cu3(HHTP)2, allow high diffusion rate and low interfacial resistance which enable the Cu3(HHTP)2 cathode to follow the intercalation pseudocapacitance mechanism. Cu3(HHTP)2 exhibits a high reversible capacity of 228 mAh g−1 at 50 mA g−1 . At a high current density of 4000 mA g−1 (~18 C), 75.0% of the initial capacity is maintained after 500 cycles. These results provide key insights into high-performance, 2D conductive MOF designs for battery electrodes.

Biography

Kwan Woo received his B.S degree in Materials Science Engineering in 2010 from Hanyang University in Korea. After graduation, he moved to Korea Advanced Institute of Science and Technology and received M.S. in 2012. During M.S. course, he developed graphene- based catalysts for PEMFC under the supervision of Prof. Jung Ki Park. In 2016, he received his Ph.D under the supervision of Prof. Jang Wook Choi. During Ph.D course, his research focused on the hydrated cathodes for high performance sodium and magnesium rechargeable batteries. After finishing Ph.D course, he entered LG Chem and then developed commercial separators for iPhone and advanced separators such as all solid type separators during 2016.02~2018.08. In September 2018, he joined to the Stoddart group in Northwestern University as a postdoctoral fellow, working on the design and synthesis of organic cathode materials for rechargeable batteries. Currently, he is currently working as an assistant professor in the Department of Chemical Engineering and Materials Science at Ewha Womans University.

Development of High-Capacity Alloy-Conversion Anode Materials for Li-ion Batteries

Xianyong Wu[1]*, Jose Fernando J. Florez Gomez,[2] and Nischal Oli[2]

[1]Department of Chemistry, University of Puerto Rico-Rio Piedras Campus, United States;

[2]Department of Physics, University of Puerto Rico-Rio Piedras Campus, United States.

Abstract

It is of critical importance to develop high-energy batteries (>250 Wh kg^{-1}) to fulfill the requirements of emerging applications, such as drones, electric vehicles, and wearable devices. Currently, lithium-ion batteries represent the prominent choice as power sources; however, the moderate capacity (~350 mAh g^{-1}) in the graphite anode restricts the energy density to 180 Wh kg^{-1}. To tackle this challenge, one effective strategy is to develop alternative anode materials with much higher capacity. In this work, we selected two alloy-conversion anode materials, *i.e.*, SnO_2 and $BiFeO_3$, as the potential anode materials, due to their low-cost and high capacity (700-900 mAh g^{-1}). We investigate the effects of binders and electrolytes on their electrochemical performance, and we found that the combination of carboxymethyl cellulose (CMC) binder and localized high-concentration electrolytes (LHCEs) lead to very stable cycling performance. The working mechanism

has been analyzed by ex-situ XRD, SEM, and EIS studies. This work highlights the effectiveness of novel electrolytes on stabilizing anode material performance.

Biography:

Dr. Xianyong Wu is an assistant professor in the Chemistry Department at the University of Puerto Rico-Rio Piedras Campus. His research focuses on the development of: (1) high-energy Li batteries; (2) non-Li batteries, such as Na/K/Zn, etc.; (3) Aqueous batteries; and (4) Solid-state batteries. He has published over 40 SCI papers in prestigious journals, such as Nature Energy, JACS, Angew, and Adv. Mater.

Experimental Analysis of Large Format LFP and LTO Cell Performance for Grid-Scale Energy Storage Systems

Matthew J Smith*, Thomas Fantham, Daniel T Gladwin

The University of Sheffield, UK

Abstract:

With the increasing proliferation of large scale, grid connected energy storage systems, it is becoming ever more important that the behaviour of the cells used in these systems is well understood, both for the validation of system models and simulations, and for the development of control and monitoring for in service use. This work presents the results of an experimental analysis of the performance of current-generation large format Lithium Iron Phosphate (LFP) and Lithium Titanate (LTO) cells intended for energy storage applications. The cells were examined to determine how their open circuit voltage (OCV) and DC internal resistance (DCIR) varied with both state of charge (SoC) and cell temperature. OCV is a critical parameter, which is often used by battery management systems (BMS) as a fundamental part of their SoC estimation routines. It is therefore vitally important to understand how OCV varies with temperature, particularly in the case of large scale systems where their physical design often leads to temperature variation amongst the cells of the storage. Internal resistance is a major source of losses within cells, therefore understanding how this varies with both temperature and SoC is crucial to fully characterise the efficiency of the cells within operational systems. Changes in DCIR over time are also used as indicators for cell degradation, therefore knowledge of all the factors which influence DCIR is critical to allowing proper and reliable assessments of degradation to be achieved.

Biography:

Dr Matthew Smith is a Research Associate in the Centre for Research into Electrical Energy Storage & Applications Group of the Electrical & Electronic Engineering Department at The University of Sheffield, UK. He graduated from the University of Sheffield with a Master's Degree in Digital Electronics in 2014 and obtained his PhD from the University of Sheffield in 2018. His research interests include Power Electronics, Electrical Energy Storage & Management and Battery Performance. Specifically, his work examines factors affecting the lifetime and performance of batteries within energy storage and automotive applications and battery testing methodologies and procedures.

Does Solar Generation Need a Battery Storage Always?

Yashar Barut

Power Market Solutions, Houston, TX

Abstract

Using actual project examples from various ISOs, we discuss the conditions under which a solar generation will be better off if a BESS is added. Using forward looking solar generation expectations and transmission problems across ISOs, we highlight the regions that will require a BESS to a solar project added.

Biography:

Yashar Barut is the founder of Power Market Solutions, a microgrid/battery storage/market strategy company. This company offers strategy and consulting services and has optimization tools for BESS. Prior to that he was the director of Power Fundamentals in Citigroup Commodities Trading for 10 years. He has over 20 years of energy market experience in various energy companies and trading organizations, which included an major integrated oil and gas company, utility companies, a private equity investment company, a hedge fund and an investment bank. In these companies, he contributed as a short and long term fundamental strategist, a risk manager, a structurer and a portfolio manager. Prior to joining the private sector, he was an assistant professor of economics at Rice University in Houston. He has a Ph.D. in Mathematical Economics and Master of Economics and Master of Mathematics from Purdue University and undergraduate degrees in Mathematics and Electrical Engineering from Bosphorus University, Turkey.

Electrolytes for Beyond Lithium-Ion Energy Storage: Nuclear Magnetic Resonance Studies of Structure and Ion Transport

Steven G. Greenbaum*

University of New York, New York, NY

Abstract

A significant bottleneck in the development of large-scale, safe, and sustainable batteries is the slow progress in electrolyte materials research. In the lithium ion battery (LIB) realm, electrolytes based on flammable alkyl carbonate solvents have seen few changes in the last quarter century and are unsuitable for lithium metal batteries. For larger scale grid storage, redox flow batteries (RFBs) which require thousands of gallons of electrolyte (catholyte and anolyte), present formulations are too costly for widespread adoption. We present here several novel electrolyte development efforts led by collaborators at the University of Maryland, Case Western University, and the University of Tennessee. Nuclear magnetic resonance (NMR) is a unique method of probing local structure and dynamics in a wide variety of materials owing to the short range nature of most of the interactions that produce spectral features and govern dynamic behavior. Among its advantages are elemental (nuclear) specificity and its reliably quantitative nature in that the integrated intensity of a particular spectral component is directly proportional to the number of nuclei in the corresponding material phase. Modern day NMR has grown into an enormously diverse array of sophisticated experimental techniques in studies ranging from complex biochemical systems in the solution phase to a wide selection of solid-state compounds, with often negligible overlap in methodology. As a counterexample of the increasing divergence between the liquids and solids NMR communities, we present here several ongoing NMR investigations of structure and ion transport in novel electrolytes, utilizing both liquid state and solid state NMR.

Biography:

Steve Greenbaum is CUNY Distinguished Professor of Physics at Hunter College and the CUNY Graduate Center, and a Fellow of the American Physical Society. He is also senior science advisor at Ionic Materials, Inc. in Woburn, MA. He earned his Ph.D. in Physics from Brown University. His main research interest involves studies of materials for electrochemical energy storage and conversion by magnetic resonance methods. He has co-authored over 300 peer-reviewed publications and was one of eleven Jefferson Science Fellows who served as Senior Science and Technology advisors to the U.S. Secretary of State during the 2014-15 academic year

Geo-methanation - An Innovative Approach for Large-scale Storage of Renewable Energy in Depleted Gas Reservoirs

Andreas P. Loibner[1*], Artur Zaduryan[1], Hannes Konegger[1], Niels Waldmann[1], Stephan Bauer[3], Markus Pichler[3], and Cathrine Hellerschmied[2]

[1]Dept. IFA-Tulln, University of Natural Resources and Life Sciences Vienna (BOKU), Austria

[2]Dept. of Microbial Ecology and Ecosystem Science, University of Vienna, Austria

[3]RAG Austria AG, Austria

Abstract

Establishing a carbon neutral and sustainable energy supply is essential to successfully combat climate change. Fluctuating availability of energy from renewable resources requires highcapacity storage solutions to satisfy seasonal peak demand, which current technology does not allow for. The conversion of surplus electricity into chemical energy ("Power to Gas" concept) would allow to use exploited gas reservoirs for storing renewable energy at large-scale. The primary objective of this work was the development of a microbially-mediated technology, that involves the use of exploited natural gas reservoirs for the storage and conversion of surplus renewable electricity. Geo-methanation, based on the microbial process of hydrogenotrophic methanogenesis, was established in the laboratory at simulated reservoir conditions and tested in a field trial. Reservoir-borne microorganisms fully converted carbon dioxide and molecular hydrogen (2.5% and 10% in methane, respectively) in high pressure bioreactors (40 bar, 40°C) into methane in less than 6 days. An industrial-scale field test - injecting over 105 Sm3 of hydrogen admixed to nearly 106 Sm3 of natural gas - confirmed the conversion of carbon dioxide to methane at in situ conditions. Multiple lines of evidence, including a substantial increase in activity of methanogenic microorganisms in the reservoir, and a change to a lighter isotope signature of methane (δ 13CCH4) confirmed the microbial nature of this conversion process. Renewable geo-methane has the critical advantage of full compatibility with the established natural gas infrastructure, while natural gas reservoirs provide the required immense storage volumes. Large-scale implementation of the geo-methanation technology could prove to be a viable solution for keeping climate change at bay.

Biography:

Being an environmental biotechnologist, Andreas Loibner has focused on the investigation and exploitation of microbiological processes naturally occurring in the sub-surface. Emphasis has been put on the microbial degradation of organics such as petroleum hydrocarbons and PAHs in aerobic but also anaerobic environments in order to develop innovative techniques for aquifer and vadose zone clean-up. Recent work focused on the microbial metabolism in underground gas storages related to the introduction of hydrogen. Together with industrial partners, a geomethanation technique was developed (patent EP3280807A1) to microbiologically convert hydrogen and carbon dioxide to methane while being stored in exploited natural gas reservoirs.

Nuclear-renewable Hybrid Energy System and Its Growing Role in a Low-carbon/Carbon-free Economy

Hailei Wang* and Stephen Hills, Jacob Bryan, Seth Dana

Utah State University, Logan, UT

Abstract

With growing penetration of renewables, nuclear – renewable hybrid energy systems (N-RHES) are expected to play an instrumental role in future low-carbon/carbon-free grids and the overall decarbonation strategy for the economy. A typical N-RHES consists of at least a renewable, a nuclear energy system, an energy storage and/or an end-use system. They work collaboratively to meet the increasingly dynamic loads while improving overall system reliability, performance, and economics. In this talk, I will discuss the steps involved in designing and optimizing a N-RHES. It starts with a robust energy demand and renewable energy information (e.g., hourly wind speed, solar irradiance), which can be done using historic data or synthetic time series. This is followed by developing dynamic models for each subsystem selected. To optimize the N-RHES design, either levelized cost of electricity (LCOE) or net present value (NPV) can be chosen as the objective function. Two case studies will be presented. Case 1 aims to replace coal and natural gas with carbon-free energy sources for Texas. The optimal N-RHES design includes 19.7% of wind, 27.1% of solar and 51% of nuclear with the rest 2.3% coming from hydrogen energy. The large amount of hydrogen produced during winter, spring and fall seasons can be used as feedstock for various industries and/or energy carrier for transportation. Case 2 aims to meet energy demand of Salt Lake City using an N-RHES while producing clean water through freeze desalination. The energy-water system utilizes the stored ice energy to boost efficiency and power during peak hours.

Biography:

He is an Assistant Professor in the Mechanical and Aerospace Engineering Department at Utah State University and the Director of the Energy Technology Research & Innovation (ETRI) Lab. He has broad research expertise in heat transfer and advanced thermal energy systems. Currently, he is mentoring eight graduate students and five undergraduate students. His work has been funded by various federal agencies including NRC, DOD, and several DOE offices and programs. Some recent work has also been funded and supported by various companies. He has published over 50 journal and conference papers, and hold three granted patents and multiple patent applications.

Leveraging New Grid Interconnection Standards to Streamline Energy Storage and Hybrid System Integration and Optimization

Charlie Vartanian* and Jaime Kolln

Pacific Northwest National Laboratory, Richland, WA

Abstract

Technical standards referenced and implemented by legislation and regulatory policy can accelerate adoption of advanced grid technologies, while preserving grid reliability. An example is the United States' Energy Policy Act of 2005 citing IEEE Standard 1547 for consideration by States when establishing or updating respective DER interconnection rules. Setting common minimum performance standards for PV connected to power systems facilitated a period of massive expansion in both the number and the size of PV systems in the United States.

Today, more complex DER systems are being deployed using an array of technologies and related performance capabilities. These capabilities extend beyond PV simply supplying clean energy. Today, DER systems provide services including capacity services, firmed/shaped renewable energy, ancillary, and resiliency services. Newer DER configurations delivering broader capabilities include hybrid PV+ES systems and grid-integrated microgrids. ***IF*** IEEE 1547-2003 had not been updated in 2018, some of the noted services would not be compliant with 1547. This paper features changes in IEEE 1547-2018 being leveraged to streamline the interconnection of hybrid PV+ES systems. Specifically, system level vs asset-by-asset compliance, and requirements for intentionally islanding DER in 1547-compliant manner. This paper also provides a brief case study based on a PNNL microgrid: multiple DER managed as a single integrated system from the perspective of the connecting utility. Using this approach, 1547-compliant functions for the microgrid will be assigned to a BESS, so that the other clean energy producing assets (PV, tidal) can optimize their energy output to provide maximum value.

Biography:

Charlie Vartanian is a Senior Technical Advisor at the Pacific Northwest National Laboratory where he focuses on integration of energy storage with power systems. Charlie has 25 years of industry experience deploying advanced grid technologies, performing system studies, and contributing to standards development. Prior employers include Mitsubishi Electric, DNV KEMA, the California Energy Commission, and Southern California Edison (SCE). During his 15 years at SCE, Charlie's professional activities ranged from T&D planning to grid technology R&D.

Towards the Solvation of Solid-Electrolyte Interphase Former in Lithium Metal Batteries

Chi Cheung Su* and Khalil Amine

Argonne National Laboratory, Lemont, IL

Abstract

Despite its exceptionally high specific capacity and remarkably low electrochemical potential, lithium metal anode is still not widely used in the commercial market because the practical application of lithium metal batteries (LMBs) was still impeded by severe safety issues originated from the highly unstable lithium/electrolyte interface and lithium dendrites formation. Among all the methods proposed in stabilizing the lithium metal surface, the re-design of electrolyte is regarded as the easiest and most cost effectiveness process. To effectively design suitable electrolyte system, however, it is crucial to understand the solvation behavior of the solvents.

In this presentation, through various electrochemical and solvation studies such as a Li||Cu cell test and IR-DOSY NMR, we successfully reveal the solvation rule for the SEI former to enable stable cycling of the LMBs. In our study, we used a very common SEI former, fluoroethylene carbonate (FEC), to enable the SEI formation because of its ability to initiate robust SEI on the lithium metal surface. All of the electrochemical test results support our hypothesis that there exists a critical ratio between FEC and a co-solvent such as dimethyl carbonate for the electrolyte of LMBs. If the FEC to co-solvent ratio is lower than the critical ratio, unstable SEI will be formed, leading to significant decomposition of electrolyte. On the contrary, if the ratio is higher than the critical ratio, i.e. the solvation number of FEC ≥ 1, stable SEI can be effectively established.

Biography:

Chi Cheung Su is a chemist at ANL and the PI or Co-PI of several DOE-funded or company-funded energy storage research projects. He possesses more than 14 years of experience in the synthesis and characterization of organic compounds, as well as more than 9 years of experience in electrolyte and electrode research covering the development of new salts, solvents, additives as well as fundamental understanding of electrolyte-electrode interfacial chemistry. Dr. Su has published over 40 papers in high impact peer-reviewed journals and holds over 18 patents and/or patent applications pending related to electrolyte applications.

Battery Performances of Hybrid Materials Comprising Polyoxometalates and Carbon Nanohorns as Cathode-Active Materials

Katsuhiro Wakamatsu[1,2]* and Hirofumi Yoshikawa[2]

[1]Massachusetts Institute of Technology, USA;

[2]Kwansei Gakuin University, Japan

Abstract:

Nanohybrids comprising polyoxometalates (POMs)[1] and nanocarbons such as carbon nanotubes and graphenes[2] have attracted attention as electrode-active materials for rechargeable lithium-ion batteries. These hybrids show an improved battery capacity due to the super-reduction of POM and the electrical double-layer capacitances (EDLCs) of nanocarbons. In this study, we focused on oxidized carbon nanohorns (CNHox) as a nanocarbon with a higher surface area and direct access to the inner structure owing to the aperture treatment at the tip, and evaluated the battery performance using POM/CNHox hybrids as cathode-active materials. As a result, POM/CNHox hybrids maintain high capacities even at high current densities. X-ray absorption fine structure (XAFS) analysis was also performed to investigate the reaction mechanism of these hybrids. Then, it was found that the excess capacity of the POM/CNHox hybrids except the POM redox capacity cannot be explained by using the EDLCs of CNHox, suggesting that not only a higher surface area but also specific structures of CNHox is important for realizing high performances. These findings show an improved performance compared with previous reports[2] and can contribute to the development of active electrode materials for next-generation rechargeable batteries. We believe that our findings will direct the attention of the battery research community toward the possible application of POM hybrids as active electrode materials. Detailed results and discussion will be reported at our presentation at this conference. References: [1] H. Wang *et al.*, *J. Am. Chem. Soc.*, **134**, 4918 (2012)., [2] K. Kume *et al.*, *J. Mater. Chem. A*, **2**, 3801 (2014).

Biography:

Katsuhiro Wakamatsu is the postdoctoral associate of Prof. William H. Green's group at the Department of Chemical Engineering, MIT. His research interests include the study of catalytic reaction mechanisms and the development of novel electrode materials for rechargeable batteries and fuel cells using both computational and experimental methods. He received his Ph.D. in engineering under Prof. Teppei Ogura from Kwansei Gakuin University, Japan in Jul. 2020. After that, He worked as a postdoctoral associate in Prof. Hirofumi Yoshikawa's group at Kwansei Gakuin University before joining the current group in Nov. 2021.

University of Regina Launches Bachelor's Program in Energy Systems Engineering

Phillip Choi*, Na Jia

University of Regina, Canada

Abstract

The oil and gas industry continues to play an essential role in the global energy market, but so too, is the emerging clean energy industry due to the increasing energy demand and the world's effort to achieve net-zero greenhouse gas emissions to address climate change.

In response to the rapidly changing energy landscape, the University of Regina (UofR) has expanded the Petroleum Systems Engineering program (PSE) through the creation of the Energy Systems Engineering Program (ERSE), effective the Fall of 2023. The ERSE Program contains three options (Petroleum Engineering, Sustainable Energy Engineering, and Energy Transportation and Storage). This program is a broad category of engineering that deals with energy production, transportation, and storage in efficient, economical, and environmentally-friendly manners. The Petroleum Engineering option contributes to the responsible extraction of underground oil and gas presently dominating the energy sector. The Sustainable Energy Engineering option introduces the technologies that are committed to climate action by developing renewable energy resources, such as solar, wind, geothermal, hydro, and nuclear energy. The Energy Transportation and Storage option focuses on knowledge development in energy distribution, conversion, and storage systems essential for sustaining the increasing energy demands. These three options synergistically facilitate the seamless transition into the future market of energy.

The ERSE program at UofR is the first energy-related comprehensive program within Canada. It offers three options in one program, and the multidisciplinary curriculum will educate and cultivate future engineers while providing them the essential skills in the multiple disciplines required in the energy industry.

Biography:

Phillip Choi is the Dean of the Faculty of Engineering and Applied Science at the University of Regina while Dr. Na (Jenna) Jia is an Associate Professor and the Chair of the Petroleum Systems Engineering Program.

The Buried Properties of Layered Carbon Achieve Higher Energy in Lithium-ion Batteries

Tereza M. Paronyan

HeXalayer LLC, Louisville, KY

Abstract

Carbon structures are the commonly used anode material in current commercial Li-ion batteries (LIBs) due to several advantages including high power capacity, environmental stability, and long-term cycling performance. However, improving the rechargeable battery energy density remains a challenge for many battery applications. Hexalayer develops a new class of unconventional layered carbon anode material containing slightly rotated high-quality graphene layers called incommensurate multilayer graphene (IMLG). We study the correlation of original graphene interlayer rotation to the specific capacity of LiBs applied as an anode material. The weekly interaction of graphene layers is caused by slight rotation to each other due to the synthesis process which makes available intense diffusion of Lithium atoms into storing active material/anode and provides up to five-fold (~1800 mA/g) reversible capacity improvement throughout long-term cycling. This new Innovative technology promises a new generation of lightweight high energy

Biography:

Tereza M. Paronyan is a Chief Scientist and Co-Founder of HeXalayer, LLC, she is also a Professor of Physics at Bellarmine University, KY, USA. Dr. Paronyan earned her Doctorate degree in Applied Physics in 2003 and has many years of postdoctoral experience working on nanomaterials and Energy storage areas. Since 2008 her research has been directed to the Carbon nanomaterials synthesis and investigation of electronic devices and energy storages. Her current focus is developing of graphene layered structures as an advanced anode material for rechargeable batteries. She is currently leading Hexalayer's projects to scale up and commercialize her innovative technology for the next-generation high-energy density batteries. Her innovations and monographs have been published in high-impact journals Encyclopedias, and handbooks as well.

Applications of Perovskite Nanocrystals in Solar Energy Conversion

Peter Schall

University of Amsterdam, The Netherlands

Abstract

The search for efficient, cost-effective sustainable energy is among the most important societal challenges of our times. While traditional solar cells made from silicon are reaching their fundamental efficiency and price-reduction limits, a paradigm shift, possibly involving integration of photovoltaics into human habitat (buildings, cars, clothing), is urgently needed to meet the ever-increasing energy demand.

Recent developments in semiconductor nanocrystals (NCs) and 2D materials promise the advent of a new generation of cheap, flexible and potentially highly efficient photovoltaic devices made by bottom-up assembly. In particular, metal-halide perovskites and perovskite nanocrystals are promising candidates due to their superior optoelectronic properties and defect tolerability, having seen an unprecedented rise of interest in recent years.

In this talk, I will show how the assembly of nanocrystals can be directed into structures most useful for solar energy harvesting and conversion, and I will discuss principles that affect the efficiency of potential photovoltaic devices. I will show how light absorption can be increased by simple photonic design, and how photon recycling can be used to keep the light within the active layer. Finally, I will discuss applications of these nanocrystals as light-emitting fluorophores that convert light color to adjust the solar spectrum to make it most useful for photosynthesizing plants, hence increasing biomass yields.

Biography:

Peter Schall is Professor in Condensed Matter Physics at the University of Amsterdam. He obtained his PhD at RWTH Aachen (Germany) in 2002, after which he performed postdoctoral research at Harvard University (U.S.A). In 2005, he joined the physics faculty at the University of Amsterdam (The Netherlands), where he holds a chair in Soft Condensed Matter Physics since 2014. His recent focus includes semiconductor nanocrystals and two-dimensional materials, researching fundamentals of light-matter interactions with applications in energy conversion. His work includes more than 120 papers, reviews and book contributions. He is also editor of the European Physical Journal, and the Springer book series "Biophysics and Soft Condensed Matter".

Posters

Toray Slot-die Coating for Perovskite Solar Cell & Electrochromic Smart Window

Katsumi Araki[1*]

Toray Engineering Co., Ltd., Japan

Abstract

Toray Engineering Co., Ltd.'s slot-die coater, with the world's #1 sales track record in the LCD color filter industry, is our leading product, having full line-up to the world-largest G10.5 size. With other manufacturing equipment in our listing, we offer equipment to other industries including semiconductor, construction, solar battery, and pharmaceuticals, etc. In the perovskite solar cell & smart window industry too, our leading-edge integrated production line with our slot-die coater playing a key role, can be utilized to wet coat material for them.

In our posters, actual application examples of perovskite layer coating and electrochromic smart window coating are introduced. This poster shall thus demonstrate our experiences in both processes, and how our state-of-the-art slot-die coater can serve manufacturing needs in each field.

Biography:

Katsumi Araki has joined Toray Engineering Co., Ltd. in 2017. After spending one year as an engineer for the slot-die coater, he has been working in the Sales Department since 2018. He is mainly in charge of sales and marketing for the manufacturing equipment of perovskite & electrochromic smart glass.

FTIR Spectroscopy as a Non-destructive Analysis for Solid Biofuels' Quality Control

Supitchaya cherdkeattikul *, Yusuke Morisawa, Tamio Ida

Kindai University, Japan

Abstract

The carbon-neutral solution in the iron and steel industry is still a big challenge for the densified biomass sector. The reason is that densified biomass has low strength compared to coal coke. The products' strength feature is critical in the iron and steel application since they must withstand massive loads during production. This presentation focuses on the densified product called bio-coke (BIC), which is produced under a sub-critical water state. BIC product has high compressive strength compared to traditional densified biomass. The current coal coke substitution rate of BIC in cupola furnaces is around 20 percent. A preliminary study on the BIC application in the preheating type arc furnace is promising. This research aims to apply FTIR spectroscopy in the BIC research to determine the chemical reactions and predict BIC's strength using a chemometric procedure. A thorough understanding of these reactions is crucial for BIC strength development. The combination of FTIR and principal component regression for the product's strength determination is a novel concept, but it has potential as a quality control procedure. This concept is beneficial in BIC study and the other densified products. This study produced BIC samples from Japanese cedar mixed with additional cellulose, hemicellulose, and lignin at various ratios. There is a correlation between BIC's strength and chemical changes observed within the spectrum. Two parameters

that characterize FTIR spectra in 1800-1500 and 800-400 cm-1 regions explained 64.8% of BIC strength's variance prediction with Adj. $R2 = .648$, $F (2,45) = 44.127$, $p < .001$.

Biography:

Supitchaya Cherdkeattikul, a Thai native, is a research engineer with experience in analytical chemistry, solid-biofuel analysis, and renewable energy in a multicultural and multidisciplinary team in Japan. After graduating with a doctoral degree in mechanical engineering, she continues her research in an analytical approach to solid biofuels' quality control at Bio-coke Research Institute, Kindai University. She has a passion for clean steel manufacturing, environmental issues, and sustainable initiatives.

The dual shocks of the COVID-19 and the oil price collapse: A spark or a setback for the circular economy?

Selmi, R., Hammoudeh, S., Kasmaoui, K., Soussa, R.M., Errami, Y

ESC PAU BUSINES SCHOOL, FRANCE

Abstract

Is the COVID-19-induced unprecedented plunge in oil demand good news for the nascent circular economy in a material made from oil (i.e., the recycled plastics)? Since the plunge of oil prices, recycled plastics have become more expensive than virgin plastics, potentially encouraging manufacturers to shift away from the former to the latter. Our study primarily attempts to address whether recycled plastics will survive the tanked oil prices and COVID-19. To this end, we assess how the dual shocks of COVID-19 and the associated oil price collapse affect: (i) the dynamic co-movements between the international crude oil prices and the plastic and recycled plastic prices, and (ii) the responses of virgin plastics and recycled plastics in terms of diversification opportunities. Using different empirical methodologies (i.e., the event study methodology to assess changes in prices beyond expectations, the optimal hedge ratio, the portfolio weight, and copula-based approaches), the findings robustly suggest that with the rising uncertainty over COVID-19, the oil market and the performance of virgin plastic manufacturers are still significantly and positively connected, although a negative dependence with the recycled plastics is shown. With the onslaught of the coronavirus pandemic, the inclusion of virgin plastics in a portfolio composed of oil only improves the reward-to-risk ratios. These results have relevant implications for risk management and policy design. Biography: Kamal Kasmaoui is an Assistant Professor of Economics and Econometrics at ESC Pau Business School. He holds a Ph.D. (with Distinction) in economics from Pau University and a master's degree in mathematics, statistics, and economics engineering from Bordeaux University. Dr. Kasmaoui's areas of academic expertise are econometrics, development and social economics, and well-being. His teaching experience includes various undergraduate and graduate-level courses in econometrics, economy and financial economics. The author's works have been published in several scientific journals, along with occasional papers and book chapters.

An Environmental Assessment of a Residential Building in Europe: A Case Study

Jaron Schembri, Valentina Stojceska* & Maria Kolokotroni

Brunel University London, UK

Abstract

The reduction of greenhouse gas (GHG) emissions has become a top priority for the European

Union (EU) in the resent years. The building sector is one of the main contributors to GHG emissions accounting around 40% to the EU's total energy consumption and 36% to the CO_2 emissions. This study investigates an environmental impact assessment of the refurbishment of a multi-family residential building in Switzerland, with the objective of reducing greenhouse gas emissions. The refurbishment of the building included the addition of two floors, improvement of the building's thermal envelope, replacement of existing active elements with more efficient ones, and the installation of a photovoltaic panel system. The environmental impact assessment was conducted using SimaPro software to evaluate the building's environmental performance over a 50-year period following deep refurbishment. The results of the life cycle assessment showed a significant decrease in operating energy consumption, resulting in an energy payback period of 5.2 years. It was noted that the CO_2 emissions saved during the building's operation were not enough to compensate for the CO_2 emitted during the renovation process. The study highlights the importance of considering the life cycle environmental impacts of buildings, including both the embodied and operational energy, when assessing the effectiveness of renovation strategies to reduce greenhouse gas emissions. Further research and development are necessary to identify more effective strategies to reduce the environmental impacts of building renovation while achieving the desired energy efficiency and comfort levels.

Biography:

Valentina Stojceska, is employed as a Reader at Brunel University London. Her main research interests are in the area of sustainability, resource and energy efficiency. She has an extensive industrial and academic experience in sustainable food processing, which she has put into practice via extensive collaboration with the food industry. She has successfully developed and delivered numerous projects sponsored by national and international funders. Currently, she is involved as a Principal investigator (UK-BUL) side in EU funded project "Application of Solar Thermal Energy in Processes". She a Course Director and supervises postdoctoral research assistants, postgraduate and final year students and lectures on the MSc and BSc courses.

The Use of Multiple Impingement Jets in a Solar-Powered Tube Heater for Decarbonization of the Steel Industry

Hadi Tannous*, Valentina Stojceska and Savvas Tassou

Brunel University London, UK

Abstract

The steel industry commonly uses electric-based induction heaters to heat steel tubes to a temperature of 240°C prior to powder-based coating. This leads to higher electricity consumption and environmental impact of the industry. In this study, a solar-powered tube heater is developed to reduce the use of the induction heater and environmental impact. It employed multiple air impingement jets to effectively heat the tubes without interrupting the coating process. The main challenge of multiple impingement jets systems was optimizing their critical parameters that include the distance between the jets and the target (Z/D_{jet}), consecutive jets circumferentially (Y/D_{jet}) and axially (X/D_{jet}), and size of the jet's diameter with respect to the target's diameter (D_{jet}/D_{target}). A numerical model of the tube heater was developed using ANSYS FLUENT, where a parametric analysis was carried out to optimize these parameters and evaluate their ability to enhance the heat transfer rate while maintaining a low required air fan power. Results showed that the Z/D_{jet} ratio has a directly proportional effect on the two aspects; heat transfer rate and required fan power. Its optimum value that achieved the highest difference between the two aspects was 2. The same effect has been seen with Y/D_{jet} and X/D_{jet} with the optimum ratios of 4 whereas the D_{jet}/

D_{target} showed an inversely proportional effect with an optimum ratio of 0.409. It was concluded that optimizing the critical parameters improves the heat transfer rate by 12% thereby reducing the use of the induction heat and subsequently environmental impact of the industry.

Biography

Hadi Tannous is a Doctoral Researcher at Brunel University London (BUL). He holds a MSc degree in Sustainable Energy: Technology and Management (BUL) and a BSc in Sustainable and Renewable Energy Engineering, University of Sharjah, UAE. His research interest lies in the use of solar energy for decarbonization of the industrial processes. Currently, he is researching a novel tube heater that employs multiple air impingement jets for the application of innovative solar thermal collectors and enhanced thermal storage systems in the steel tube industry.

Keynotes

Australia is the Global Solar Pathfinder

Andrew Blakers

Australian National University, Australia

Abstract

Australia is the global solar pathfinder. Australia is generating twice as much solar energy per person compared with any other country. Australia (per capita) has the most installed solar capacity and is installing solar and wind 3 times faster than the USA and 10 times faster than the global average.

The National Electricity Market and the state of South Australia have reached combined solar & wind energy penetrations of 30% and 70% respectively and are tracking towards 50% and 100% respectively in 2026. The Australian grid is likely to occasionally reach 100% renewable energy on sunny and windy days by 2025. The Government target is 82% renewable electricity by 2030.

Australia is providing compelling evidence that balancing high levels of solar and wind is straightforward using off-the-shelf technology. About 15 GW of pumped hydro (600 GWh) has been announced or is under construction – with no new dams on rivers – for a population of 26 million people. Many GW of batteries and transmission is also under construction.

All 8 provincial Governments and the National Government are determined to move rapidly to rid the electricity system of fossil fuels following price spikes caused by high gas and coal prices caused in part by Russia's invasion of Ukraine.

Electrification of land transport (via electric vehicles), air & water heating (via electric heat pumps) and industrial heating (via electric furnaces) is the next target.

Australia is showing that its not actually difficult to move quickly to high levels of solar & wind.

Biography:

Andrew Blakers is Professor of Engineering at the Australian National University. In the 1980s and 1990s he was responsible for the design and fabrication of silicon solar cells with world record efficiencies. He was co-inventor of the PERC silicon solar cell, which has 90% of the global solar market, cumulative module sales of US$100 billion and is mitigating 1.5% of global greenhouse gas emissions through displacement of coal. Prof Blakers engages in analysis of energy systems with 50-100% penetration by wind and photovoltaics. His team developed a comprehensive global atlas of 616,000 off-river pumped hydro energy storage sites.

Development of Low-carbon Blast Furnace Ironmaking Technologies to Mitigate Carbon Dioxide Emission

Shibo Kuang[1]* and Aibing Yu

ARC Research Hub for Computational Particle Technology, Monash University, Australia

Abstract

The steel industry is one of the biggest industries consuming fossil fuels like coke and

ABSTRACTS

coal intensively. The blast furnace (BF) ironmaking process represents about 70% energy consumption and carbon dioxide emission in an integrated works. Therefore, the efficiency of BF is key to reducing the footprint of the steel industry. In this direction, our research team has endeavored to explore various low-carbon ironmaking technologies in recent years. This is done by developing and applying a process BF model based on computational fluid dynamics (CFD). This talk will present an overview of such efforts made by our research team. The development and validation of the CFD BF process model will be introduced. Then, the application of the model to low-carbon ironmaking technology developments will be demonstrated. It will cover the low-carbon ironmaking technologies based on conventional and innovative BFs. The former focuses on the optimization of the top and bottom BF operations, while the latter considers mainly the development of oxygen/hydrogen BFs.

Biography

Shibo Kuang is currently a research fellow in ARC Research Hub for Computational Particle Technology at Monash University. His research interests center around computational process engineering. It aims to achieve fundamental elucidation, theory and method establishment, new technology exploration, and process optimization for multiphase transportation and processes, ultimately reducing the cost and minimizing the impacts on the environment. Both physics-based models and data-driven (AI) models are thus developed and applied. He published over 120 publications, including 95 journal papers collected in Web of Science. He has been invited to deliver over twenty invited lectures at international avenues.

Smart Harvesting of Thermal Energy to Deliver Essential Utilities

K.J. Chua

National University of Singapore

Abstract

This presentation focuses on the harvesting of waste thermal energy to develop a unique quadgeneration plant, whereby all four key utilities, namely, electricity, heat, chilled water, and potable water, are generated simultaneously using a single, integrated system in an energy efficient manner. This is accomplished by maximizing the recovery process of the generated waste energy. Specifically tailored for tropical countries, the plant can contribute to greater energy and cost savings, and is also more space-efficient. It employs an innovative temperature matching and cascading heat-flow method to maximum waste-heat utilization of waste. More importantly, it can markedly reduce energy consumption by 30 per cent or more to deliver essential utilities while potentially trim the amount of carbon dioxide emitted to the environment by 2 to 4 per cent for countries at business-as-usual levels while meeting varying needs of electricity, potable water, cooling and heating. Such a novel system is particularly suited to countries whereby cooling and water production are essential utilities.

Biography:

Chua Kian Jon has been conducting research on modelling and experimental works for specific thermal energy systems. He has more than 200 international peer-reviewed journal publications, 6 book chapters and two recent monographs on advances in thermal energy system. He was highlighted to be among the top 2% of global energy scientists based on Elsevier's database and top 0.3% in the Stanford list of energy researchers. He has been elected to several fellowships including Fellow of Institute of Mechanical Engineering, Fellow of Royal Society, and Fellow of

Energy Institute. His works has garnered more than 11,500 over citations with a current h-index of 56. He is the Principal Investigator of several multi-million competitive research grants and has been awarded multiple local, regional, and international awards for his breakthrough research endeavors.

In-Situ Testing of Swell Packers in Saline Water and Crude Oil

Sayyad Zahid Qamar[1], Tasneem Pervez[1] and Maaz Akhtar[2]

[1]Mechanical and Industrial Engineering Department, Sultan Qaboos University, Muscat, Oman

[2]Mechanical Engineering Department, N.E.D. University of Engineering and Technology, Karachi, Pakistan

Abstract

Enhanced oil recovery (EOR) targets maximum well productivity and total recovery from oil and gas wells. One EOR technology is installation of downhole smart systems to control flow from each lateral. In contrast with conventional methods, swelling elastomer seals maintain good zonal isolation in even complex environments, and yield significant savings in rig time and cost. This paper describes the design, fabrication, and commissioning of a full-scale setup for longevity testing (5-year period) of different swell packers in in-situ conditions. The test battery was developed at Sultan Qaboos University, in collaboration with a regional petroleum development company. Different swelling elastomer materials are exposed to actual crude oil or water of different salinities, maintained at ambient and high temperatures, and subjected to normal and high pressures. Salient features of the test rig include heating systems for some packers; recirculation system to maintain requisite salinity levels; sophisticated system for measurement of upstream and downstream temperatures and pressures in all packers; and pressurizing system (upto 1000 psi) after completion of swelling-based sealing. Initially daily, and then weekly, log of measurements were maintained over the 5-year testing period. Maintenance of the heating, circulation, pressurizing, and measurement systems over several years was a daunting task. Packers exposed to low salinity and higher temperatures sealed earlier, and water-swelling elastomers sealed faster than oil-swelling ones. Seal deterioration or failure was observed in some cases. Some packers re-sealed after reduction of applied pressure. No information about the reliability or longevity of different swelling elastomer packers was available before this study, especially for various actual field conditions over an extended time period. This study provided direct feedback to field engineers about the lasting capability of different elastomer types under various actual field conditions, and is valuable in proper selection of swell packers and in improvement of packer design. **Keywords:** Enhanced oil recovery, swell packers, test setup, longevity testing (5-year), in-situ conditions, high temperature, high pressure

Biography:

Zahid Qamar Sayyad is a Professor of Mechanical Engineering Department at Sultan Qaboos University (SQU), Muscat, Oman. He has over 30 years of academic and research experience in different international universities. He has also worked as a professional mechanical engineer in the field for over 6 years in the heavy engineering and fabrication industry (Manager Research and Development; Deputy Manager Design; Production Engineer; Quality Control Engineer). On top of his experience as a researcher/academician, he has been actively involved in research and accreditation work related to engineering education. His technical research areas are Applied materials and manufacturing; Applied mechanics and design; Reliability engineering; and Engineering education. As part of the Applied Mechanics and Advanced Materials Research group (AM2R) at SQU, he has been involved in different applied research funded projects in excess of 4 million dollars. He has over 225 research/technical publications to his credit (research monographs/books, edited book volumes, book chapters, publications in refereed international journals and conferences, and technical reports). He has recently edited one volume (Renewability of Synthetic Materials) for the Elsevier Encyclopedia of Renewable and Sustainable Materials, and is currently editing one volume (Thermal Engineering of Steel Alloy Systems) in the 13-volume series Comprehensive Materials Processing, 2nd edition by Elsevier. He has served as Associate editor, Guest editor, and Member editorial board for different research journals (including Materials and Manufacturing Processes, Journal of Elastomers and Plastics, the Journal of Engineering Research, American Journal of Mechanical and Industrial Engineering, etc).

Creating a Symbiotic Relationship Between Regional Industry as a Holistic Approach to Industrial Decarbonization

Andrew R Barron*[1,2,3]

[1]Energy Safety Research Institute (ESRI), Swansea University, Swansea, SA1 9EN, UK. Arizona

[2]Institute for Resilient Environments and Societies (AIRES), University of Arizona, Tucson, Arizona

[3]Department of Chemistry and Department of Materials Science and Nanoengineering, Rice University, Houston, Texas

Abstract

The technological challenges for industry to reach UK's legislated Net Zero targets by 2050 represent an 'Apollo moment' for decarbonization. With less than 30 years to achieve Net Zero emissions it is too late for more research. Now, is the time to deploy at scale on industrial locations to demonstrate technology and de-risk with regard economic viability, system integration, operational safety, and social acceptance. However, attempting to implement single technologies within a single industry will not provide the solution. Instead there needs to be a holistic approach that considers the waste and emissions, as well as materials and energy needs of a region (or country) as a whole instead of the individual parts. Furthermore, the development must be symbiotic, with a mutually beneficial relationship between different stakeholders, i.e., the integration of heavy industry with agriculture, healthcare, tourism and domestic waste and needs. The Reducing Industrial Carbon Emissions (RICE) project is an example of the 'dress rehearsal' for such an approach, incorporating: green hydrogen as a replacement for natural gas as an energy source as well as an industrial reagent; biorefinery conversion of CO_2 to protein for animal and human consumption as well as high value chemicals; carbon capture and conversion using electrolysis to alkanes and alkenes; waste resource recovery and re-use to lower raw material mining and transport; waste plastic re-cycling as high value products for Li-ion batteries and carbon conductors replacing copper, and decreasing emissions associated with water treatment.

Biography:

Barron is the Sêr Cymru Chair of Low Carbon Energy and Environment at Swansea University, and Director of the Energy Safety Research Institute. As author of over 500 publications, his research focused on fundamental problems in energy and the environment. He is a Fellow of the Royal Society of Chemistry, and the recipient of the Star of Asia International Award and the World Technology Award. His latest commercialization ventures are technologies for water purification of produced water, anti-viral mask for the COVID crisis, and carbon negative hydrogen production. For relaxation Barron races cars on both sides of the Atlantic.

Plastic Trash to Monomers and Intermediates – PTMI

Anne M. Gaffney

Idaho National Laboratory, Idaho Falls, ID

Abstract

To address the issue of waste plastics in landfills, a hybrid approach is proposed. This would use low temperature plasma pretreatment followed by catalytic cracking to augment the conversion of waste polyolefins into monomers, intermediates, new polymers and value-added chemicals. Lightweight packaging (LWP) comprises about 50% of total plastics consumption and consists mainly of single and multilayer films and containers. LWP is heterogenous, contaminated and is difficult to recycle. Mechanical recycling is currently the only commercial approach to recycling but is inadequate to address the growing volume of packaging plastics and degrades or downcycles both polyethylene (PE) and polypropylene (PP). In contrast, feedstock recycling converts polymers to monomer feedstock that can be used to make new products that have virgin-like performance in high volume single use packaging applications, thereby creating new value chains for what is currently a waste stream. Current high TRL feedstock recycling technologies like pyrolysis and gasification are highly energy intensive, require multiple steps (plastics-syngas-methanol-olefins) and have low selectivity to polyolefin building blocks (ethylene, propylene). Alternatively, plastics upcycling aims at selectively deconstructing polymer in a one-step process directly into monomers and high value chemicals (HVC). Consequently, it is proposed to use a hybrid approach of preconditioning with a low temperature plasma followed by catalytic cracking for conversion of waste polyolefins into monomers, intermediates, new polymers and value-added chemicals. This offers improvement in carbon utilization, cumulative energy demand and selectivity to recycled high value products over current benchmark feedstock recycling processes like gasification and pyrolysis. It is suggested to use LTP treatment as a tunable polyolefin functionalization step to increase selectivity of subsequent catalytic deconstruction and reconstruction. The target waste stream is post-industrial and post-consumer packaging waste, mainly LDPE, LLDPE, and PP films. The primary target products from this novel process are C2-C4 olefins (ethylene, propylene, butylene) which are the raw materials for bulk of the volume of single use plastic production (PE and PP). Aromatic and other HVC precursors like benzene, toluene, xylene (BTX), ethyl benzene and polyols are also expected as by-products from the process. All the

products and by-products (C2- C4 olefins, BTX, polyols, HVC) can be upcycled to resins, bulk

(polyethylene, polypropylene) and specialty polymers (polyurethanes, epoxy, polyester, Nylon-6) at different market entry points.

Biography:

Anne M. Gaffney is the Chief Science Officer of Idaho National Laboratory and Distinguished National Lab Fellow (2014 – present). She has thirty-four years of experience working in industry inventing and commercializing new technologies for major chemical manufacturing companies including Koch Industries, Lummus Technology, Dow, Dupont and ARCO Chemical Company. She has authored 155 publications and 257 patents. Dr. Gaffney is also a distinguished Joint Appointment Fellow at the University of South Carolina (2018 – present) where she is the Technical Director of the National Science Foundation Center for Rational Catalyst Synthesis. Some of her recent awards include: the 2019 American Chemical Society, Energy & Fuels, Distinguished Researcher Award in Petroleum Chemistry; the 2015 Eugene J. Houdry Award of the North American Catalysis Society; the Chemical Heritage Foundation, Women in Science Inductee, 2014; and the American Chemical Society, Industrial Chemistry Award, 2013. Dr. Gaffney received her BA in chemistry and mathematics from Mount Holyoke College and her Ph.D. in physical organic chemistry from University of Delaware.

Parallel Session-I

Future Energy Systems for Net-Zero

Tony Roulstone

University of Cambridge, UK

Abstract

Zero-carbon emissions targets, such as that in the UK, will mean that electricity will have to be zero carbon and demand will double by 2050 as electricity substitutes for other energy sources. The low and falling cost of wind and solar energy will lead to them being dominant. Other zero-carbon energy sources will need to complement filling the gaps in supply and the fluctuations of demand. Very large amounts of energy storage – many days of annual demand - utilizing a variety of storage technologies, will be required to ensure that 2050 electricity systems are extremely reliable. Other zero-carbon supplies are able to reduce the range of supply fluctuations and make the energy system more robust. Currently, these are all more expensive than wind and solar. If operated to complement intermittent renewables will make them more expensive. Design issues for future energy systems are explored using UK as an example but the results will relevant to other countries that have a net-zero carbon target and where wind provides most of the renewable power.

Biography

Tony Roulstone established the Nuclear Energy Masters programme in the Department of Engineering at the University of Cambridge. His research interests are the economics and safety of nuclear power. He has led several SMR research projects. . Also, he led a group on energy storage needs for the Royal Society Working Group on Energy Storage and is involved with projects on the industrialisation and the economics of fusion. He is a Fellow of the Institution of Mechanical Engineers, an Associate Member of the Nuclear Institute and an independent adviser on SMR design.

Hydrogen Storage in Carbon-based Materials from Agrifood Wastes

Chiara Milanese,[1*] Ilaria Frosi,[1,2], Alessandro Girella,[1] Vittorio Berbenni,[1] Giacomo Magnani,[3] Daniele Pontiroli,[3] Mauro Riccò,[3] Adele Papetti[2]

[1]Pavia Hydrogen Lab, C.S.G.I. & Chemistry Department, Università di Pavia, Italy

[2]Pavia FoodLab, Drug Science Department, Università di Pavia, Italy

[3]Nanocarbon Laboratory, DSMFI, Università di Parma, Italy

Abstract

Recently biochar, the carbon side-product in the pyrolysis/gasification of residual waste biomasses, started to receive a widespread attention in the field of energy-storage, thanks to its hierarchical porous structure inherited from biomass precursors, its excellent chemical and electrochemical stability, high conductivity, high surface area and inexpensiveness. In particular, biochar converted to activated carbon (SSA > 1000m^2/g) through a chemical treatment with KOH appears to be a new cost-effective and environmentally-friendly carbon material with great application prospect in the field of energy-storage. We report here on the preparation of novel hierarchically-porous

super-activated carbon materials originating from biochar derived by the pyrolysis of agrifood wastes such as rice bran, corn cobs, asparagus stems, and melon and pumpkin peels. The chemical activation process proved to be efficient to remove the majority of impurities other than carbon, stabilizing highly porous hierarchical structures with local graphene-like morphology. The porous compounds obtained by mixtures of rice bran and husk demonstrated to behave as excellent electrode materials for high-performance symmetric supercapacitors (SCs), reaching interestingly high specific capacitance. On the contrary, the materials obtained by rice bran or the vegetable peels, having specific surface area up to 3000 m^2/g, show a very good hydrogen storage ability, adsorbing reversibly up to 4.5 wt % of hydrogen in around 20 seconds at 77K and around 1.5 wt% at room temperature. Work is in progress to optimize the pyrolysis and activation conditions and to improve the sorption performance of the materials by decoration with transition metals.

Biography

Chiara Milanese is associate Professor at the Physical Chemistry Section of the Chemistry Department – Pavia University, where she is the scientific coordinator of the Pavia Hydrogen Laboratory. Her main research activities regard the preparation and characterization of innovative materials for solid state hydrogen storage and energy storage and topic linked to circular economy. She is Italian expert of the task 40 “Energy storage and conversion based on hydrogen” activated by IEA and member of the International Hydrogen Carrier Alliance. She is author of 230 papers on materials science topics on high impact factor journals (h index 35).

Electrodeposition of Ni nanoparticles from Deep Eutectic Solvent and Aqueous Solution Promoting High Stability Electrocatalyst for Hydrogen and Oxygen Evolution Reactions

Safya Elsharkawy*[1], Ibrahim El-hallag[2]

[1,2]Faculty of Science, Chemistry Department, Tanta University

Abstract

The synthesis of non-precious bifunctional electrocatalyst for water splitting is very asupecious topic. In this work, the deposited non-nobel metals such as Ni, Co, Mn, Fe and their quaternary alloy Ni-Co-Mn-Fe bifunctional catalyst from acetate bath were tested as electrocatalyst for both water splitting reactions (HER and OER). It was found that the quaternary Ni-Co-Mn-Fe alloy has the highest catalytic activity for both HER and OER with the smallest overpotential value of -110 mV for HER and 310 mV for OER. Further, it has the smallest Tafel slope value 124 mV dec^{-1} for HER and 99 mV dec^{-1} for OER. Providing its highest catalytic activity compared with each single metal. The electrodeposition process was performed using chronoamperometry technique and the deposits were characterized by scanning electron microscope (SEM), Transmission electron microscope (TEM), energy-dispersive X-ray spectroscopy (EDX), and x-ray diffraction (XRD). The electrodeposition process and the electrocatalytic behavior of Nano- films were performed using the chronoamperometry and linear sweep voltammetry techniques, respectively.

Biography:

I have graduated from Faculty of Science in 2017 and passed the premaster courses in 2018. I got the first rank in 200 students so, Tanta university hired me in a tenured teaching position. I have the master degree in 2021 in Physical and Inorganic Chemistry. Moreover, I have published 3 papers in electrocatalysts for energy application. April 2022-Present: I got a promotion to be Assistant Lecturer in Tanta University. April 2017- Present: Member of the Egyptian Syndicate of Scientific Professions. • Jan 2016- Jan 2017: Member of the Egyptian Association for Cancer Research.

The Implications of Integrating Large-Scale Solar PV into a Network Supplied by Large Nuclear Power Plants

Bandar Jubran Alqahtani*[,1,2,3], Dr. Abdulrahman Salman Almerbati[3,4]

[1]Duke University, USA; [2]Saudi Aramco, Saudi Arabia; [3]King Fahd University of Petroleum & Minerals, Saudi Arabia; [4]IRC for Renewable Energy & Power Systems, Saudi Arabia

Abstract

Nuclear energy is an important contributor to global clean energy supply. Despite the fact that most of clean energy plans focus on renewable resources to reduce the GHG emissions, nuclear energy along with the energy storage will continue to play a role in meeting future clean energy goals alongside with other forms of clean energy worldwide.

This paper examines the impact of operating large baseload nuclear power plants on integrating large amount of solar PV capacity in a power network. More specifically, the paper estimates the maximum integration level of solar Photovoltaic (PV) capacity within the power network under different scenarios embody different assumptions about the flexibility of nuclear power plants (NPPs) operations. Under each scenario, the expected total system's electricity generation costs, energy mix, atmospheric emissions reductions, and emissions abatement costs are calculated and analyzed. The case study is based on the Duke Energy Network, a major power network in the United States. The network serves 4.1 million customers located over a 137,270 km2 service area across several states and meets the electricity demand through total power generation capacity of 35,797 MW.

Analysis reveals that improving NPPs operations maneuverability would increase the maximum solar PV penetration level in the Duke energy networks by 39%, from 8.9% to 12.4% of the total system's electricity generation. Consequently, it would further improve the electricity generations' unit costs and CO2 emissions reductions by 3% and 8% points, respectively. On the other hand, increasing the solar PV penetration limit under high flexible NPPs operations scenario leads to an increase in the CO2 emissions abatement costs by 8% points.

Biography:

Bandar J. Alqahtani is the Work Director of the Regulatory, Market and Policy Group in Saudi Aramco/Power Systems. He holds B.S. and M.Sc. degrees in electrical engineering from KFUPM, M.Sc. degree in the environmental science and policy and PhD degree in energy engineering and economics from Duke University, USA in 2015 and 2018, respectively. Upon graduation in 2002, Bandar joint Saudi Aramco and worked at different organizations such as Southern Area Oil Operations, Engineering Services and Power Systems. He has led different teams to carry out several projects related to process optimization, energy conservation and automation & control systems. Bandar has been awarded several innovation prizes and he has published and presented more than 30 peer-reviewed articles, technical papers and engineering reports. He is accredited Certified Energy Manager (CEM), Project Management Professional (PMP), Associate Value specialist (AVS), ISA Certified Automation Professional (CAP) and Green Belt Lean Six Sigma.

P3HT Composites based on MoS2 Functionalized for Optoelectronic Applications

M.C Arenas-Arrocena[1*], S. García-Carvajal[1*], M. E. Nicho[2]

[1]Escuela Nacional de Estudios Superiores Unidad León, Universidad Nacional Autónoma de Mexico, Boulevard UNAM #2011 Col. Predio El Saucillo y El Potrero Comunidad de Los Tepetates C.P. 37684 León, Guanajuato, Mexico.

[2] Centro de Investigación en Ingeniería y Ciencias Aplicadas, Universidad Autónoma del Estado de Morelos, Av. Universidad 1001, Col. Chamilpa, C.P. 62209, Cuernavaca, Morelos, México.

Abstract

Flower like MoS_2 microspheres with diameter of about 1-3 µm were successful synthesized by a one-step hydrothermal method, the "flower" is made up of several dozen petal-like lamellae with a thickness of approximately 19 nm. MoS_2 flowers were functionalized with diethyl[2-hydroxy-2-(thiophen-3- yl)ethyl]phosphonate and 2-tiophene carboxylic acid, and synthesized by Grignard Metathesis synthesis with (3HT) monomer, P3HT/MoS_2 composites were synthesized by using a 2,5-dibromo-3-hexylthiophene/MoS_2 weight ratio of 1:0.05. P3HT/MoS_2 functionalized composites were characterized by ^{1}H NMR, FTIR, XRD, UV–Vis, TGA and TEM analysis. Effect of functionalization of flower like MoS_2 on properties in P3HT/MoS_2 composites was studied. Functionalization of flower like MoS_2 nanostructures promotes the preservation of the regioregularity, conjugation length, percentage of crystallinity, decomposition temperature, even though the presence of nanoparticles in the polymeric matrix of P3HT produces disorder between chains and therefore the decrease in the P3HT properties, therefore these composites become attractive to be tested in photovoltaic devices.

Economic Feasibility of Onshore, Offshore Wind and Photovoltaic Energy for the State of Kuwait

W. K. Al-Nassar*, H. Alaqeel, and S. Neelamani

Kuwait Institute for Scientific Research, Kuwait.

Abstract

Two renewable energy power plants of 10MW capacity each, one photovoltaic plant (PV) and the other is wind, located in the Shagaya area, west of Kuwait, were compared after one year of operation. A study was also conducted to evaluate the offshore wind power potential in the state of Kuwait.

The results clearly showed that wind energy recorded energy production numbers that far exceeded the industry average. This was clearly associated with the very high capacity factors throughout the year, resulting in an annual power production of 42.59 GWh, 21% higher than expected (contractual 31.160 GWh), which was 2.3 times higher than that of PV; powering 450 homes compared to 199 homes for PV, and reducing emissions throughout the projected lifetime of 25 years by 118,303 tons of CO_2, 2.3 times higher than that by PV.

Offshore wind energy annual power production for a 10 MW capacity, however, was calculated to be 34.05 GWh. This would power 360 homes annually with a total CO_2 reduction throughout the project life of 94,581 tons.

Annual production of both technologies were measured, CAPEX (capital Expenditure) and OPEX (operation expenditure) were taken into consideration throughout the life of the plants along with investment costs, ultimately resulting in a levelized cost of electricity (LCOE) for wind of 0.05 USD/kWh, compared to 0.09 USD/kWh for solar PV and Offshore. Thus, the LCOE value for onshore wind power production is 44% lower than that of PV and offshore wind energy. Al-Nassar et al. (2018).

Biography:

Waleed K. E. Al-Nassar - Renewable Energy Consultant and Project Manager. A member of the steering committee of The Energy Transition in Kuwait and member of the Advisory Committee of the Supreme Council for the Environment under the Supreme Council for Planning and Development. A Research Scientist under the Renewable Energy Program at Kuwait Institute for Scientific Research (KISR) Personal Renewable Energy advisor for the former Chairman of the General Secretariat of the Supreme Council for Planning and Development and the former First Deputy Prime Minister and Minister of Defense of Kuwait, the late Sheikh Nasser Sabah Al-Ahmad Al-Sabah

Targets of Renewable Energy 2030 Wind – Solar – Bioenergy and CO2 Reduction 70% in Denmark, by Large Programs of Energy Efficiency, -Savings and Renewable Energy Integrations. Denmark as Case Example, How to Reach 100% Renewable Energy by 2040

Jens Bo Holm-Nielsen

Aalborg University, Denmark

Abstract

How will Denmark and other European countries reach the targets of getting all electricity from renewable sources year 2030? The government and parliament of Denmark have agree on a target of reducing 70 percent CO2 year 2030. This is quite ambitious so all technologies needs to be put in operation of Renewable Energy systems integration and at the same time large amounts of energy savings overall in the societies. This energy savings will account for 25 pct. reduction of the former energy utilization. Energy efficiency and energy savings are large scale programs. There is a big movement, but still a weak point, how to reach big conversion goals in the transportation sectors moving from fossil fuels. This includes the heavy transportation, aviation and shipping. Here it can only be reached by introducing Power to X programs, to skip the fossil fuels and reach large targets by fulling the transportation sectors by methanol, methane gases and ammoniac among others. Examples will be given of how to reach a large proportion of Renewable Energy supplied by combining Wind energy – Solar Energy and Bioenergy in Denmark and the Northern Europe integrated with storage and combined refinering processes.

Keywords: Green Transition, Renewable Energy Systems. Integration Wind-Bioenergy-Solar. Power-to-X, Energy Saving and Energy Efficiency. Green transportation fuels. 100 percent renewable energy 2040

Biography

Jens Bo Holm-Nielsen; Ph.D. Head of Research Group of Bioenergy and Green Engineering, Department of Energy, Aalborg University, Denmark. 40 Years of experience in the field of Renewable Energy Systems, Wind & Solar and Biorefinery concepts and Biogas production. Experience of a variety of EU projects, Organizer of international conferences, workshops and training programsin EU, Ukraine, Canada, USA, India and China.

Decarbonizing Transportation Fuels via Regenerative Carbon Sources

Stella Bezergianni* , Athanasios Dimitriadis and Loukia Chrysikou

Centre for Research & Technology Hellas, CERTH

Abstract

The fluctuating prices and depletion of fossil energy sources have expedited the development of advanced biofuels based on regenerative carbon sources. Novel advanced biofuel production technologies towards decarbonizing the transportation sector are investigated worldwide, focusing

on high throughputs, high fuel quality characteristics, and low production costs.

Catalytic Hydroprocessing is one key conversion technology of bio-based feedstocks and intermediates that enables the sustainable production of low-carbon drop-in fuels. The latest research trends in lipids hydroconversion to hydrotreated fatty acids and esters (HEFAs) will be presented as well as the catalytic hydroconversion of pyrolysis oils and Firscher-Tropsch waxes, rendering synthetic biofuels that can be suitable for long-distance transportation fuels (jet, diesel).

Besides the production of drop-in biofuels, hydroprocessing also enables the direct infusion of bio-based energy carriers (lipids/bio-oils) in underlying refineries, enabling the reduction of the carbon foot-print of the produced transportation fuels. Co-hydroprocessing of lipids or pyrolysis bio-oils is foreseen as one of the most promising routes to decarbonize the transportation sector by rendering hybrid fuels. The miscibility, compatibility and stability of the bio- and fossil-based feedstocks/intermediates is evaluated as a means of choosing the most suitable co-processing counterparts. Finally, a comparison of stand-alone hydroprocessing vs. co-hydroprocessing is performed outlining the advantages and disadvantages of each approach from a technical and environmental perspective.

Biography:

Stella Bezergianni is a research director at the Centre for Research and Technology Hellas. She has a bachelor's and a PhD degree in Chemical Engineering, extensive industrial experience in ExxonMobil research and engineering division, while she is involved in renewable fuels technologies as the head of the hydroprocessing group of CERTH since 2005. She has over 50 publications in scientific journals, is involved in numerous biofuels R&D projects supported by EU, national and private funds, active member of scientific committees within the EU, and recipient of scientific and innovation awards.

Integrated Biorefinery Producing Biofuels from Municipal and Industrial Biowaste

Mai Sofia*, Elli Barampouti, Kostas Passadis and Dimitris Malamis

National Technical University of Athens, Athens, Greece

Abstract

Bioenergy from waste streams could stand as a technical and economical viable alternative since it is highly available and free of cost. Biorefineries have attracted much attention recently for the production of biofuels and other value-added products. In the concept of an integrated biorefinery, different scenarios involving the production of biofuels from waste streams will be presented and discussed. The case study of a multi-feedstock biorefinery of 1tn/d capacity installed in Athens, Greece will be analyzed. The overall scheme includes the following tailored designed process units: a rotary drum dryer, a prototype oil extraction unit, an ethanol bioconversion unit coupled with a multistage distillation unit and a plug flow anaerobic digestion unit. The implementation and demonstration of this innovative biorefinery concept for the production of bioethanol, used oil (raw material for biodiesel), biogas and other bioproducts from municipal biowaste produced from household and catering (restaurants, cafeterias and bakeries) and/or industrial biowaste produced from selected food industry sectors (brewery, potato processing and orange juice extraction) will be discussed. The mass and energy balances will be presented along with the achieved GHG emission savings from the substitution of fossil fuels with advanced biofuels. In view of the performance data, the realization of this circular economy concept will be assessed, pointing out apart from the great potential of this biorefinery approach, the several great challenges that are still ahead of designing an ideal biorefinery.

Biography:

Mai Sofia is a Laboratory Teaching Staff (EDIP) at the School of Chemical Engineering, NTUA since 2014. Her research interests focus on the development of effective municipal and industrial waste management technologies, the recovery of useful, commercial products (biofuels, chemical blocks) from waste recovery, as well as the development of integrated waste management lines in accordance with the principles of biorefinery and circular economy. Her research work is reflected in 59 publications in reputable international journals, in the publication / editing of 1 book, in 3 chapters in books, and in 100 papers in International and National Scientific Conferences.

The Energy of Destruction as an Indicator of the Thermomechanical Properties of Rocks in the Sudetes Region (Poland) under Various Temperature Conditions

Alicja Bobrowska*, Andrzej Domonik*, Ewa Jagoda*

University of Warsaw, Faculty of Geology, Poland

Abstract

Tests carried out on various rock samples from the Sudetes region (Poland) were tested for physical parameters, as well as strength and deformation parameters. The study of uniaxial compression of samples of selected rocks and the system of graphical determination of the internal energy of the rock at various stages of deformation allows for a broad picture of the behavior of rocks subjected to various temperatures and degrees of water content. The research covers the evaluation of Young's Modulus and Poisson's Ratio. Such analysis makes it possible to predict long-term aging processes of rocks by means of modeled, accelerated laboratory tests.

Correlating Structure and Conversion Efficiency in Polymer Blends Analyzed using the Critical Point Model of the Permittivity

Rafi Shikler*[1,2] and Tal Elbaz[1]

School of Electrical and Computer Engineering, Ben-Gurion University of the Negev, Israel[1]

Ilse Katz Institute for Nanoscale Science and Technology, Ben-Gurion University of the Negev, Israel[2]

Abstract

In this work we show for the first time how spectroscopic ellipsometry can be used to analyze the correlation between the morphology and power conversion in organic blend based organic solar cells. It is well known that controlling the morphology in these cells is crucial for the optimization of their efficiency. One of the observed changes when controlling the morphology via aealig or solvent selection is the changes in the absorption spectra. We demonstrate that parametric description using the critical point model gives additional information that was previously only accessible by x-ray diffraction based techniques. We analyzed the dimensionality of the excitons as extracted from the model and found a one-to-one correspondence with observed peaks in the x-ray spectra. These findings are then correlated with the IV and power conversion efficiency of the cell. Our results indicate to the immense potential of using a macroscopic measurement technique, ellipsometry, to analyze the dynamic of microscopic changes in the active layer morphology.

Biography:

Rafi Shikler has a Ph.D. in Electrical Engineering from Tel-Aviv University at 2003. Following his Ph.D. he joined the optoelectronic group at the Cavendish Laboratories under the supervision of Prof. Sir Richard Friend focusing on organic based optoelectronic devices. Since 2008 he is a member of the ECE School at Ben-Gurion University of the Negev combining the study of the physics of organic based devices and soft fabrication techniques. He has more than 70 papers in peer reviewed journal and conferences proceedings.

Green Energy Ship Market and New Battery Supply Boat Design

Zuhal Er*

Istanbul Technical University, Maritime Faculty, Istanbul, Turkey

Abstract

In studies conducted in many countries on energy saving and CO_2 emission reduction demands, new most of the designs are geared towards renewable energy sources. Solar energy and energy storage systems can be a solution to pollution problems by reducing CO_2, SO_X and NO_X emissions. Battery technologies appear as a promising method to increase this, and we argue that environmental problems in short-distance sea transportation will be reduced with renewable energy technologies that offer zero emission opportunities.. Since most of the new designs are for renewable energy sources and technology is fast used and above items are motivation of this study The target is to design a new design environmental battery supplier vehicle Battery Supply Boat (BTS as barge support for green ships. In this study, what has been done on the basis of green energy marine vehicles in the past and today and the green ship markets are examined. In addition, this study, which will set an example for near-road transportation on green energy ships and battery service on green ships, will be an important example for those who are interested in the subject. The design of the boat is the original value of this study. Another uniqueness is to introduce the new terminology ("battery supply boat") to maritime transport. In the output of the study, the green ship markets were examined, discussions were made on solar energy and electricity storage at the ports, and the goal of achieving the new design electric service boat model targets was realized.

Biography

She received her MSc degree in Nuclear Energy Institute (Istanbul Technical University-ITU-), and her PhD degree from the Institute of Energy-ITU. She was also a visiting professor at the Maritime Academy of Australia with the scholarship by the World Maritime Organization-IMO. With the ITU JICA project, she conducted the installation of Sequence Circuit Laboratory. Until now, she was a constructer of several courses at different faculties in ITU and Isik university. She has a lot of studies in several of national-international scientific events, and in the journals. She is reviewer/ referee in international/national journals and she is a scientific committee members.

Theoretical Analysis of Green Hydrogen Production in the Pacific Northwest Region

Selisa F. Rollins[1, 2,*], Rob J. Diffely[1], T.L. Alford[2]

[1]Bonneville Power Administration, Portland, OR, USA; [2]School for Engineering of Matter, Transport and Energy, Arizona State University, AZ, USA

Abstract:

This study estimated the production of green hydrogen from excess hydropower energy in the Pacific Northwest Region of the United States. Potential hydrogen production from March through July was determined from 11 hydroelectric projects along with the Columbia River System. Results show the system's total monthly average hydrogen production potential ranges from 2445 tons

to 9876 tons with the utilization of surplus energy over a historical 80-water-year period (1928-2008). This study concludes that hydrogen production from spilled hydropower energy and its use in transportation is a viable opportunity to lead the country towards a hydrogen economy.

Biography:

Rollins is an operations research analyst in the Regional Coordination Group at Bonneville Power Administration. In this role, she conducts hydrologic and system reservoir regulation studies supporting long-term power planning objectives for the Federal Columbia River Power System. As an adjunct faculty, Ms. Rollins currently teaches Introduction to Engineering Design courses at Rio Salado College. She has a BS and MS in Chemical Engineering from Arizona State University.

Building Energy Efficiency Improvement via Solid Oxide Fuel Cell (SOFC) based Cogeneration System

Praveen Cheekatamarla*

Oak Ridge National Laboratory, USA

Abstract

Investigation of the application of hybrid PV-SOFC configuration in both residential and commercial buildings will be presented. Comparative studies between baseline residential building supplied with grid electricity and fuel for heating, and the hybrid cogeneration system will be discussed. The influence of such hybrid configurations on annual carbon dioxide emissions for a broad range of regions with varied electric grid carbon intensities will be presented. Case studies comparing the energy and economic performance of heat pump and hybrid PV-SOFC in regions with higher thermal loads (>100 kWh/day) and moderate to high carbon intensities (0.34 kg/kWh – 0.87 kg/kWh) will be discussed. The impact of integrating such PV-SOFC configurations in commercial buildings such as midrise apartment, primary school, small hotel, and outpatient clinic in lowering the carbon footprint and operating energy expenditure while improving resiliency, and peak shaving capability will be presented.

Biography:

Praveen Cheekatamarla is a Senior Researcher at ORNL focusing on developing clean, energy efficient building technologies. He has over 15 years of industrial experience and served as a technical leader. He was the Director of R&D at Atrex Energy and was the principal developer of fuel cell products. His primary areas of interest include cogeneration, catalysis, electrochemistry, thermo-chemical processes, energy modeling/analysis, fuels, combustion, reactors, and process/product development. Dr. Cheekatamarla holds a Ph.D. in Chemical Engineering and has more than 60 publications/presentations, two patents. He is a guest editor, and editorial board member for technical Journals and acts as technical advisor for energy startups.

Hydrogen Crossover Mitigation in Proton Exchange Membrane Water Electrolyzers

Stoyan Bliznakov[1]*, Zhiqiao Zeng[1], Ryan Ouimet[2], Allison Niedzwiecki[2], Leonard Bonville[1], Christopher Capuano[2], Katherine Aers[2], Radenka Maric[1]

[1]Center for Clean Energy Engineering - University of Connecticut, USA,

[2]Nel Hydrogen, USA

Abstract

Reactive spray deposition technology (RSDT) is a flame assisted method that combines the catalysts synthesis and deposition directly on the membrane in one-step, which results in fast and facile fabrication of advanced large scale membrane electrode assemblies (MEAs) for proton exchange membrane water electrolyzers (PEMWEs). The RSDT fabricated MEAs are with one order of magnitude lower platinum group metals (PGM) catalyst loadings in their electrodes and have catalytic recombination layers (RLs) integrated in the volume of the MEAs, that effectively suppress the H2 crossover. RSDT-fabricated RLs demonstrated effective reduction of H2 crossover from 30-50% of the LFL to less than 10% of the LFL when operating at current densities between 0.58 A cm-2 and 1.86 A cm-2 . These recombination layers are with Pt loading of only 0.02 mgPt/cm2 and are incorporated in the volume of the membrane of the RSDT-fabricated MEAs. The MEAs with an active area of 86 cm2 and low catalyst loadings (0.3 mgIr cm-2 in the anode and 0.2 mgPt cm-2 in the cathode) have been tested for over 5000 hrs, and it was found that the H2 crossover increased to about 15 % of the LFL after 2000 hrs of operation. In order to improve the durability of the RLs, a new design comprised from two RLs separated with thin (10 um) Nafion membrane, has been fabricated by the RSDT, and the results from the stability test of 3000 hrs will be presented and discussed in detail at the GEM-2023 meeting.

Biography:

Stoyan Bliznakov is an Associate Research Professor in the Department of Chemical and Biomolecular Engineering, and an Associate Director for the Research Infrastructure at the Center for Clean Energy Engineering at UCONN. He earned his Ph.D. degree in Electrochemistry from the Institute of Electrochemistry and Energy Systems at the Bulgarian Academy of Sciences. Following his doctoral studies, Dr. Bliznakov worked as a post-doctoral research associate in the Chemistry Department at Binghamton University. After that his career continued as a senior research associate in the Chemistry Division at Brookhaven National Laboratory. His research interests are in the development of electrochemical energy conversion and storage devices including water electrolyzers, fuel cells and rechargeable batteries

Biofuels and Food Security: Evidence from Indonesia and Mexico

Aicha Lucie Sanou[1]*, Mohamed Boly[2]

[1] Universite Clermont Auvergne, F-63000 Clermont-Ferrand, France

[2]Poverty & Equity Global Practice, The World Bank, Washington D.C, USA

Abstract

In this study, we analyze the food security effects of biofuel production using the synthetic control method. This retrospective and graphical analysis focuses on Indonesia and Mexico from 2000 to 2013. Indonesia is a major biodiesel producer, while Mexico specializes in maize and ethanol. Our findings show that biodiesel production positively affects food security through an increase in daily per capita energy consumption and the food production index, whereas we observe the reverse effect for bioethanol. After the adoption of biofuels, the gap between Indonesia and its counterfactual allows us to conclude that biodiesel production does not harm food security. This could be explained by the fact that biodiesel production uses some feedstocks that do not directly compete with food crops; moreover, biodiesel exports generate revenues that can be allocated to food imports. However, the gap between Mexico and its counterfactual suggests that bioethanol production reduces food security because it uses maize, which is the staple food of many Mexicans. Furthermore, Mexican ethanol exports compete with those of the United States. Our results are robust to several falsification tests.

Biography

Aicha Lucie SANOU is an economist with research interests in development economics and questions related food security, climate change, renewable energies such as biofuels environmental economics. Aicha is about to defend her Ph.D. in development economics specifically biofuels and food security at the Universite Clermont Auvergne. She is working as a consultant at the World Bank on the resilience of West Africa's food systems. Before her Ph.D., Aicha got a master's in Economic Analysis and International Development specializing in Sustainable Development from the Universite Clermont Auvergne, France.

Biological Strategies to Recover Biohydrogen from Wastes: The Clostridial Way

Francesca Valetti*

University of Torino, Italy

Abstract

Bio-hydrogen production via dark fermentation of low value waste is a simple mean of recovering energy, maximizing the harvesting of reducing equivalents to produce the cleanest fuel amongst renewables. Following several position papers from companies and public bodies, the hydrogen economy is regaining interest, especially in combination with circular economy and short local supply chains, aiming at zero GHG emission.

The biomasses attracting the largest interest are agricultural and urban green wastes (tree pruning, collected leaves, grass clippings from parks and boulevards), which are usually employed in compost production, with some concerns over the GHG emission during the process. Also, special wastes like bioplastics and cellulosic products, such as fluffs used as absorbent, are largely produced and expensive to treat.

We have studied, from a biochemical point of view, the hydrogen production from several type of wastes: the bio-catalysts investigated as mainly relevant for hydrogen production were the [FeFe]-hydrogenases expressed in Clostridia, given their very high turnover rates.

By enriching green wastes, low value compost and intermediate products (partially composted but unsuitable for completing the process), waste bioplastics and fluffs, with selected strains such as *C. beijerinckii* AM2 and *C. tyrobutyricum* AM6, analyzing and setting the optimal condition for hydrogenases genes expression, we can enhance hydrogen production from nutrient-poor wastes in a perspective of circular bioeconomy, even in absence of pre-treatment or sterilization applied to waste and without negative effect from the autochthonous microbial consortium [1].

[1] Arizzi, Morra, Gilardi, Pugliese, Gullino , Valetti. Biotechnology for Biofuels 14: 182 (2021)

Biomethane into the demonstration Microgrid of the Renewable Energy Centre

Carla Asquer

Sardegna Ricerche, Renewable Energy Centre, Cagliari, Italy

Abstract

Microgrids are local energy grids where loads, sources, and storage systems are interconnected and grouped so that they constitute a single controllable entity. The advantages and scope of a microgrid are emphasized by using renewable energy sources instead of fossils. In the Renewable

Energy Centre of Sardegna Ricerche, Italy, a demonstration microgrid is available for academic and industrial research. The Microgrid includes biomass and photovoltaic as energy sources, and several kinds of technologies for energy conversion, storage, and utilization. Bioenergy is integrated into the Microgrid through biomethane production from biogas through two routes: upgrading via absorption with chemical reactions and biological hydrogenotrophic methanation. The latter is an emerging technique that can be performed in the anaerobic digester itself (in-situ) or an additional biological reactor (ex-situ). Both chemical upgrading and biological methanation allow for obtaining nearly pure, renewable, and biogenic CH4. Integration is the main feature of our system and is extended through the biomethanation pathway. This process uses hydrogen as an electron donor in the biologically catalyzed conversion of CO2 into CH4, representing a transition from Power-to-hydrogen to Power-to methane as well. Hydrogen is generated from the excess electricity of the intermittent renewable source, which is photovoltaic in our demonstration grid. However, both hydrogen and CO2 could derive from other industrial processes, so that their conceptualized roles in a microgrid can be maintained. In this work, the Renewable Energy Centre Microgrid is described, with a focus on the features and role of the bioenergy sector and biomethane production and utilization.

Biography:

Carla Asquer is an Environmental Engineer, Ph.D., and a researcher at the Renewable Energy Centre operation site since its foundation in 2010. Her affiliation, Sardegna Ricerche, is a Regional Government Agency that promotes research and innovation. Her fields are biomass and biofuels, particularly biogas and biomethane. She oversees the laboratory management, design, and planning of the experiments. She organizes the operation and maintenance of the anaerobic digestion, upgrading, and biomethanation pilot plants. She is also in charge of the dissemination of results of the activities conducted by the Centre in the bioenergy sector.

Heat of reaction for biomass pyrolysis

J. R. Jones*[1], Q. Chen[1], N. Caco[1] and G. D. Ripberger[2]

[1]Massey University, New Zealand

[2]Fonterra Research and Development Centre, New Zealand

Abstract

Designers of pyrolysis reactors need good data about the expected heat of reaction of pyrolysis. However, pyrolysis is complex, involving several hundred reactions, which are generically divided into endothermic primary and exothermic secondary reactions. The balance of these profoundly affects the overall heat of reaction of pyrolysis. For a designer, it is important to know when heat is required and where heat needs to be extracted to achieve and maintain the target highest treatment temperature (HTT). Here, we report on the influence of several variables on the overall heat of reaction. We develop a catalysis model to explain the effect of both the path length of travel as volatiles escape from biomass particles and the internal pressure. The path length of travel correlates to biomass particle size (an operating parameter) and to bed volume (a design parameter). Pressure generated depends of the pore size distribution within particles (an inherent property), the particle size (an operating parameter), the bed volume and the system pressure (both design parameters). With assumptions about catalysis sites, site occupancy and reaction kinetics, two generalized secondary reaction schemes are explored. In the first, heterogeneous and homogeneous secondary reactions compete for the primary reactive volatiles. In the second, the secondary reactions apply only to dedicated fractions of the primary reactive volatiles. Of the schemes, the second best explains how biomass particle size and system pressure influence the

overall heat of pyrolysis. In this way, prediction of overall heat of pyrolysis is possible.

Biography

Jim Jones is a professor of chemical engineering at Massey University, New Zealand. He received his B.E.(Hons) degree from the University of Canterbury, NZ, M.S. from the University of Idaho, USA, and PhD from the University of Cambridge, UK. His career started in pulp and paper in NZ and USA, before moving to minerals processing in Australia, before returning to academia. His research interests are broad, covering particle technology and reaction engineering in food and environmental engineering, and natural hazard systems. He has a particular interest in biomass pyrolysis.

Use of Solar Energy for Sustainable Agri-food System

Eugene Rurangwa, Adin Yeton Bloukounon Goubalan, Djibril Drame, Patrice Savadogo and Aissatou Mboup Aissatou

Food and Agriculture Organization of the United Nations, Subregional Office for West Africa

Abstract

Energy use in Africa has remained constant, accounting for only about 4% of global energy consumption in agri-food systems. Limited access to reliable and affordable energy at each step of the agri-food system limits the ability of farmers and agri-enterprises to raise productivity, cut losses and cope with shocks. Solar energy plays a fundamental role in food systems transformation. It serves at all stages of the agricultural value chain, directly in primary production, as well as in secondary activities such as drying, cooling, storage, transport, and distribution, and indirectly in the manufacture of fertilizers, agrochemicals, and agricultural machinery. In so doing, it can advance efforts to end hunger, reduce drudgery, lower greenhouse gas emissions, increase the adaptive capacity of farmers and agri-enterprises, raise incomes, and lessen the environmental impact of the food sector. At the same time, it can contribute to gender equality and youth employment. In African agri-food systems, the solar-powered irrigation system is widely adopted to improve access to water, thus enabling multiple cropping cycles and increasing resilience to changing rainfall patterns due to climate change. FAO has successfully experimented with some solar driven-models in West and East Africa to improve agricultural value chain competitiveness. These include a full-equipped Solar Powered Irrigation System, solar-powered grain milling business models', solar energy-based cold storage facilities'; drying and cooking solar energy models. This chapter highlights the status of solar-powered energy use in African agri-food systems, provides country-specific successful models and addresses the common challenges for their scaling up in rural areas.

Key words: Food security, agri-food value chains sustainable food and agriculture, solar energy technology

Renewable Aviation Fuel Production Processes in Mexico: A Comprehensive Approach

Claudia Gutiérrez-Antonio*, Carlos Eduardo Martínez-Guzmán, Araceli Guadalupe Romero-Izquierdo and Sergio Iván Martínez-Guido

Autonomous University of Querétaro, México

Abstract

Renewable aviation fuel has been identified as the most promissory alternative for the sustainable

development of aviation sector. This biofuel can be produced from several raw materials through different processing pathways. Unlike other biofuels, aviation biofuel must fulfill the same technical standards of its fossil counterpart as well as sustainability standards in order to be used in commercial and freight flights. In addition, the price of aviation biofuel must be competitive respect to fossil jet fuel. Moreover, the production process must be as safe as possible, as well as its supply chain must be optimal.

Therefore, this work presents a comprehensive approach of the production processes for renewable aviation fuel in México. For this, it selects the most promissory raw materials in México for the production of renewable aviation fuel through hydroprocessing. Considering the composition and availability of these raw materials, the hydroprocessing to produce aviation biofuel is modeled and simulated. Then, the obtained results from simulations are used to generate several catastrophic scenarios for each scheme, in order to know possible consequences and to evaluate the safety index of these processes. Besides, a supply chain development is shown to optimize the transportation network. Finally, the production processes for biojet fuel in México will be compared and discussed considering technical, economic, environmental, safety and distribution aspects in its complete supply chain.

Biography

Doctor of Science in Chemical Engineering from Technological Institute of Celaya, and Professor-Researcher at Faculty of Engineering of the Autonomous University of Querétaro; her research area is the development of sustainable biofuels production processes. She has published 50 research articles, 20 book chapters, and three books. On the subject of aviation biofuels, she collaborated in the preparation of National Development Plan (2012-2018, 2019-2024). She leads the research group Sustainable Processes for the Production of Bioenergy, which is part of the Ibero-American Network of Biomass Technologies and Rural Bioenergy. Also, she collaborates with the Querétaro Energy Cluster, chairing the Innovation Committee.

Halide Perovskites based Efficient Indoor Photovoltaics for Sustainable Internet of Things

Lethy Krishnan Jagadamma*, Shaoyang Wang, Alasdair Bulloch, Paheli Ghosh

Energy Harvesting Research Group, SUPA, University of St Andrews, North Haugh, United Kingdom

Abstract

Halide perovskite indoor photovoltaics (PV) are promising to autonomously power the billions of sensors in the emerging technology field of the Internet of Things. However, there exists a knowledge gap in the hysteresis behavior of these photovoltaic devices under indoor lighting conditions. The present work is dedicated to exploring the degree of hysteresis in halide perovskite indoor photovoltaic devices as a function of device architecture and the selection of photoactive layers. Hysteresis properties were examined through both transient J–V scan and steady state maximum power point tracking (MPPT) measurements. It was observed that when $MAPbI_3$ is used as the photoactive layer, compared to p-i-n device architecture consisting of all-organic charge transport layers, the n-i-p devices with metal oxide charge transport layers suffered higher hysteresis. And this hysteresis effect of n-i-p $MAPbI_3$ devices got worse under the low intensity indoor illumination conditions. Our study revealed that the divergence between the PCE values estimated from the J–V scan measurements and the maximum power point tracking method was also higher under the indoor illumination compared to 1 Sun, necessitating the need to prioritize the PCE from the MPPT measurements over the conventional J–V scan measurements.

Biography:

Lethy Krishnan Jagadamma is a UKRI-Future Leaders Fellow and leads the Energy Harvesting Research Group at the School of Physics and Astronomy, University of St Andrews. Currently, her research focus is on combining material focused innovation with that of the emerging huge technologies such as the Internet of Things (IoT) and Wearables. Her research team develops scalable and efficient ambient energy harvesters to self-power disruptive technologies such as IoT so that their reliance on the battery can be reduced.

Inception of Solar Module End-of-Life Management in Australia

Richard Corkish*, Nathan Chang and David Leyton

Australian Centre for Advanced Photovoltaics, School of Photovoltaic and Renewable Energy Engineering, Australia

Abstract

It has been estimated that the flux of end-of-life (EoL) photovoltaic (PV) modules will reach 3,300 – 6,400 T/a by 2035 in Australia, based on assumed module lifetimes of 15-20 years. Although this is significantly smaller than for ash from coal fired power stations and a small fraction of total waste, increasing PV waste is a concern. The Australian Government has notified that PV systems are being considered as a priority for legally mandated regulation and has engaged consultants to advise it on the form of future management. The PV industry is strongly motivated to deliver important services with minimised environmental impacts and needs both longer-lasting modules and recovery of materials at eventual EoL, also in order to continue its own expansion in the context of finite resources. So, it is strongly incentivised to minimise waste.

Australia has a growing R&D activity in PV module end of life management. The R&D activities range from industry resource needs, collection logistics, testing/evaluation, module dismantling, module recycling, semiconductors and metals recovery, and markets for components and materials. There are also a handful of start-up and established businesses accepting EoL modules for recycling. These activities will be surveyed on the basis of public information.

Biography:

Richard Corkish, PhD in electrical engineering (UNSW) and was Head of the UNSW School of Photovoltaic & Renewable Energy Engineering 2003 to 2013. In that decade, the School's budget approximately quintupled, the student numbers reached almost 600 and SPREE alumni changed the face of the national and international industries. He is currently COO of the Australian Centre for Advanced Photovoltaics, the main platform facilitating photovoltaics device development in Australia. His current research activities are sustainability of photovoltaics technologies and their end-of-life and is founder of the UNSWERV project, bringing light and power to remote villages in Vanuatu.

The Governance of Peer-to-Peer (P2P) Energy Trading Platforms

Andres Diaz-Valdivia

RMIT University, Australia

Abstract

Digitalization will play a vital role in the achievement of successful transitions towards more flexible,

reliable and sustainable energy systems. The progressive availability of data from meters and sensors deployed across energy supply-chains constitute a first step towards this direction. Leveraging on such cross-sectorial trend, business developers find in decentralized ledger technologies -- such as the blockchain -- opportunities for value creation across a broad range of participants in energy systems. Peer-to-peer energy trading platforms interconnect legacy and novel participants leveraging renewable and storage capacity with grid operators and within local microgrids. In this way, near real time (bi-directional) exchanges can be secured and validated via tokenization and smart contracting. The proposed configurations enable governance arrangements between legacy and novel participants at the platform and sectorial level. This paper focuses on investigating the decentralized governance characteristics proposed by peer-to-peer energy trading platforms and briefly discusses their implications on legacy systems from a broad 'relational' and 'normative' set of theories. The paper draws upon prior surveys and publicly available whitepapers from business initiatives (start-ups). For the purposes of this study, whitepapers constitute official texts and sources of information for the study of emergent ways of governance and collective action leveraging this technology. Results from content analysis constituted four main categories that explain: (1) the digital features of these platforms, (2) the participants and incentives involved (3) the purposes and benefits of the solutions and, (4) the governance dynamics arising from trading tokenized energy via smart contracting. Results reveal complex multi-level socio-technical interrelations at different layers and points towards opportunities for private and community-based solutions, end-user empowerment and polycentric governance while considering fractal planning in policy design.

Biography:

Andres is economist, PhD Candidate at RMIT University's Graduate School of Business and Law, Master in Environmental and Energy Management (Twente University 2013) and Master in Corporate Finance (Barcelona University 2012). He focuses his research on the governance and law dynamics stemming from blockchain-based solutions in the energy transitions for climate mitigation. His research interests cover different areas at the intersection of economic growth, governance, institutional quality and natural resources. In addition, he is also interested in the rise of decentralized technologies and the opportunities for democratic and participative outcomes. He has published a few a scientific articles and book chapters in these topics.

A Feasible Three-steps Technological Route for Coal-fired Power Units to Achieve Carbon Neutrality Target

FENG Weizhong[1,2], LI Li[1,2]

[1]Shanghai Shenergy Power Technology Co., Ltd., Pudong New Area, 200137, Shanghai, China;

[2.]Shanghai Waigaoqiao No.[3] Power Generation Co., Ltd., Pudong New Area, 200137, Shanghai, China

Abstract

The power generation industry in China has meet an obvious dilemma toward carbon neutrality: new energy, like wind and solar power plus energy storage can't really ensure the safety of the power grid, while traditional coal power is stable, reliable and adjustable, but the carbon emission intensity is too high. Our research, practice and survey show that there is a feasible and promising technological route that can turn coal-fired power units from high to zero or even negative carbon emissions. This route includes three steps: First, coalfired power units further improve efficiency and deep load regulation capacity to reduce carbon emissions. The former is to reduce the carbon emissions of coal-fired power units themselves and the latter is to support increasing of proportion of low-carbon energy like wind and solar power while keep coal-fired power units in the power grid for safety and stability. Second, by mixed burn biomass pellets, coal-fired power units can

sharply reduce carbon emissions, even to near zero when purely burn biomass. Thirdly, based on the first two steps, CCUS technologies can be applied on coal-fired power units to achieve zero or even negative carbon emission. For the first step, our team has several representative cases on high-efficiency and high-flexibility coal-fired power units. For the second step, there is a novel and potential way to produce cheap biomass fuel based on large-scale industrialization of fast-growing plants with high calorie. A representative plant called super bamboo reed, has been invented and developed in China. Since CCUS technologies are also making progress, we are confidence that with this three-steps strategy, coal-fired power units can become stable, reliable, adjustable and zero-carbon power generation sources, making historical contribution to the carbon neutrality target of China and the world.

Semiconductor Metal Oxides for Solar Energy Harvesting

Hadi Sena*, Masayoshi Fuji

Nagoya Institute of Technology, Japan

Abstract

Metal oxides are promising materials for photocatalytic and photovoltaic applications thanks to their very stable features even under crucial environments. However, the large band gap of metal oxides restricts their application to photo-excitation under ultraviolet (UV) light. Since UV light exists only 5% in the solar spectrum, it has been the goal of many research articles to design metal oxide semiconductors with capability of absorbing visible light. The fraction of visible light in solar spectrum is about 50%. The best solar energy absorption can be obtained when a photocatalyst has a band gap of 2 eV. Reducing the large band gap of metal oxides is possible by several methods such as doping with cations or anions. Although these methods lead to the successful band gap reducing, they do not necessarily result in photocatalytic activity under visible light due to the defect-induced recombination losses. In this presentation, high pressure phases of pure metal oxides will be stabilized by High-pressure torsion (HPT) method, and their photocatalytic or optical properties will be introduced.

Biography

Hadi Sena is a designated associate professor in the Advanced Ceramics Research Center, Nagoya Institute of Technology, Japan. His research focuses on crystal growth and characterization of semiconductors in solid state, liquid phase, and gas phase. Recently, he has been working on gallium nitride (GaN) based semiconductors for power devices as well as designing new materials for photocatalytic properties

Zero Emissions in the Production of Bioethanol from Agave Integrating Solar Thermal Energy

Guillermo Martínez-Rodríguez[1]*, Juan-Carlos Baltazar[2], Amanda L. Fuentes-Silva[1]

[1]Department of Chemical Engineering, University of Guanajuato, Mexico;

[2]Energy Systems Laboratory, TEES, Texas A & M University, U. S. A.

Abstract

Agave bagasse is a solid residue that arises from the processing of the agave pineapple during the production of tequila. Bagasse constitutes only 40 % by weight of pineapple and can theoretically generate up to 6254 million liters of bioethanol per year in Mexico. The production of bioethanol

from agave waste is an energy alternative to manufacture second generation biofuels. By integrating solar thermal energy into the bioethanol production process, the entire heat duty can be supplied, and greenhouse gas emissions can be eliminated. This research focuses on the development of a design methodology for solar thermal plants that deliver the heat duty for the industrial process of bioethanol production from agave, in a feasible way. Design, economic and environmental aspects are incorporated, to supply a heat duty of 4721 kW for 24 hours. The resulting cost to produce solar thermal energy is 0.0664 USD per kWh, which makes it competitive on the comparison with natural gas that reports a cost in Europe of 0.2163 USD per kWh, and emissions can be reduced to zero. 7384 metric tons of CO_2 were not emitted into the environment per year. The raw material is assured to produce bioethanol of second generation using solar thermal energy.

Biography:

Guillermo Martínez-Rodríguez, Chemical Engineer with experience at petrochemical industry, is a Mexican lecturer and researcher with 22 years of experience at University of Guanajuato, the major public state higher level institution. This researcher is convinced that the industry can continue to develop using 100 % renewable energy. He has been in charge of a Solar Testing University Laboratory since 2006, with more than 50 solar collector trademarks tested and providing consulting. His research interests have focused on the thermal and hydraulic performance of solar collectors for the innovation and integration in industrial and domestic applications; the mathematical modeling of the thermo-hydraulic phenomena that intervene in the heat transfer within the solar collectors, and solar thermal dehydration applications.

The Network Representation of Convecting Plates

Ted D. Bennett

University of California, Santa Barbara, USA

Abstract

The classical network analogy is extended to convecting plates that are characterized by four nodal temperatures associated with two conduction paths and two convective paths. This contribution allows convecting surfaces, which are ubiquitous in the design of energy systems, to be analyzed in the framework of thermal networks. Network resistances are derived for several geometries of non-isothermal convecting plates, including bars or rectangular plates of constant cross-section, as well as annular and spherical plates. Several cases of plates are considered, including with heat generating materials, and having surfaces surrounded by either one or two fluid states. This work supplements analytic tools at the disposal of thermal designers and provides an alternative to intensive numerical analysis of complex thermal structures.

Biography:

Ted D. Bennett is an Associate Professor of Mechanical Engineering at the University of California, Santa Barbara. He is also the author of *Transport by Advection and Diffusion*, New York: Wiley, 2012.

Assessment and Optimization of Solar Dryer Alternatives for Smallholder Farmers in the Tropics: A Case Study of Cassava Chips

[1,2] Amo-Aidoo, A., [2]Ribeiro, J. X., [3]Antwi, E.

[1]Kassel University, Germany; [2]Kumasi Technical University, Ghana; [3]Rostock University, Germany

Abstract

Open-sun drying is the most common among various dryers used by smallholder farmers, although it leads to waste and contamination. The study aims to determine the best solar dryer for adoption by smallholder farmers in the tropics using cassava as a case study. Two solar dryer models: Solar Tunnel Dryer and Chimney–Dependent Solar Crop Dryer, in active and passive modes, were tested for their ability to dry cassava chips in Ghana effectively. The results were analyzed using the Multicriteria Decision Model method under five main criteria (appearance, cost, temperature, moisture content, and microbial load). The Solar Tunnel Dryer ranked best. However, in active mode, it underperformed due to the lower internal temperature in the dryer from the high-speed fan. Further, the experimental data were fitted to seven different existing mathematical (Page, Modified Page, Wang & Sing, Henderson & Pabis, Newton, logarithmic, and two-term exponential) models and Artificial Neural Network (ANN) modelling. When applied to all the setups, the ANN prediction model was model with the least error margin compared to the mathematical models. The Wang & Sing model was the best performing mathematical model. However, the ANN model outperformed the Wang & Sing model.

Biography:

She has rich experience in renewable energy technologies and carbon markets worldwide. She has been a fellow in this field since November 2012. As a member of the staff of Kumasi Technical University and the solar coordinator for CREEK. She has helped champion the cause of renewable energy and energy efficiency for the institution locally (solar rooftop programme and various standalone systems) and internationally. She holds a PhD in Agricultural engineering, MSc in Renewable energy technologies and a BSc in Mechanical Engineering. She was the overall best national female engineer in Ghana in 2016 and the youngest national female council member of Ghana Institution of Engineers (GHIE).

Discussion on the Risk of Renewable Dominated Power Systems

Bo Hu[1]*, Kaigui Xie[1], Changzheng Shao[1]

[1]State Key Laboratory of Power Transmission Equipment & System Security and New Technology (Chongqing University), China

Abstract

The past years have been witnessing a dramatic expansion of renewable energy in the global, such as wind and solar energy. According to the strategic policy of energy development, renewable energy will replace fossil energy as the dominant power source in the future. Compared with the traditional power system, the renewable dominated power system (RDPS) involves additional uncertainties related to the power production and consumption. Hence, the risk assessment of the RDPS is significantly more challenging. In this report, three typical risk characteristics of the RDPS compared with the traditional power system are analyzed. Based on the characteristics, a risk assessment framework for the RDPS is constructed. Firstly, a three-level risk index system is proposed to describe the systemic risks. Then, an effective risk assessment method that reflects the risk characteristics of the RDPS is proposed. Finally, the contribution of heterogeneous risk sources to the risk of the RDPS is quantified based on the reliability tracking theory. The critical and vulnerable parts of the RDPS are identified, which provides the quantitative decision basis for the risk pre-control.

Biography

Bo Hu was born in 1983 in Henan, P.R. China. He received the Ph.D. degree at Chongqing University, China, in 2010. Currently, he is a full professor in the School of Electrical Engineering, Chongqing University. His main research interests focus on the power system reliability, planning and analysis. He is the author and co-author of over 80 academic papers and two books. He is the team leader of more than 40 academic projects, including two projects under the National Natural Science Foundation of China, and two projects under the National key Research and Development Program of China.

Transparent P-type Potassium-doped ZnO Thin Films

Sujun Guan[1] * , Tianzhuo Zhan[1] , Liang Hao[2] , and Xinwei Zhao[3]

[1]Toyo University, Japan;

[2]Tian University of Science and Technology, China; [3] Tokyo University of Science, Japan

Abstract

Transparent conducting oxides have gained much attention owing to their potential applications in several optoelectronic devices such as light emitting diodes, solar cells, and thin film transistors as well as flexible displays, owing to its excellent optical and electrical properties. To realize highly efficient solar cells devices, the development of p-n homojunction of ZnO has received considerable attention as a promising approach. However, p-n homojunction of ZnO is extremely difficult to be fabricated, especially the fabrication of p-type ZnO. To date, potassium (K) seems to be the best candidate for p-type doping. However, K is rarely used for the fabrication of p-type ZnO due to its larger radius (152 pm), compared with that of Li and Na (90 pm and 116 pm, respectively). Herein, we report the fabrication of potassium-incorporated transparent zinc oxide (K-ZnO) thin films by subjecting ZnO thin films to high-pressure molten-salt treatment (hp-MST) in potassium nitrate, which successfully led to p-type semiconductor films. With raising the hp-MST temperature, X-ray diffraction (XRD) results show that the ZnO (002) plane clearly becomes more crystalline, accompanying by larger grains. While the hp-MST temperature significantly influences surface morphology, as further revealed by scanning electron microscopy (SEM). More importantly, the carrier type of K-ZnO thin films was successfully transferred from n-type to p-type with raising the hp-MST temperature, while maintaining excellent optical performance. The oxygen species on the surface of the ZnO thin films change with raising the hp-MST temperature; in particular, the oxygen vacancies increase in number, as evidenced by X-ray photoelectron spectroscopy (XPS), which indicates that K is successfully incorporated into the surface of the ZnO thin films. Notably, the change in K 2p energy combined with the realization of p-type character by the raised hp-MST temperature suggests that K incorporation changes from interstitial to substitutional. This study introduces a simple and efficient alternative strategy for homojunction semiconductors that can be used to prepare next-generation highly efficient semiconductor devices.

Biography

Guan is an associate professor working in the Graduate School of Interdisciplinary New Science at Toyo University from April 2021. Prior to this, he worked an assistant professor in the Department of Physics at Tokyo University of Science from April 2017. He gained his PhD in Department of Mechanical Engineering at Chiba University, studying on enhancement of visiblelight absorption and photocatalytic activity of photocatalyst coatings. His current research focuses on the transparent conducting oxides thin films, such as heterojunction photocatalysts for water splitting, transparent thin film solar cell with p-n homojunction, and so on.

Spectrally Selective Nanostructures for Solar Energy Harvesting and Thermal Management

Sunmi Shin*

National University of Singapore, Singapore

Abstract

Controlling thermal emission in the mid infrared range is of great interests for thermal engineering with broad applications ranging from solar-thermal absorber to thermal camouflage, from radiative cooling of spacecrafts and terrestrial objects to building envelopes, and heat shielding. In many these applications, it is often desirable to have selective absorptance in different parts of the spectrum. For example, for many solar utilization devices (such as solar-thermal, thermoelectric, and photovoltaics), absorption in the solar spectrum is desirable for harvesting solar energy to heat or directly into electricity. On the other hand, for cooling application, it is preferred to have low solar absorption and high infrared emission. Achieving high spectral selectivity is a key strategy to enhance the figure of merit of the thermal absorbers or emitters. I will present my work aiming to achieve the spectral selective feature using nanostructures for these two opposite applications. Furthermore, I will introduce a novel approach to adopt the nanostructures to manipulate thermal radiation. I could achieve a near-monochromatic far-field thermal emission, which is a big departure from the incandescent behavior as described by the Planck's law. The key feature of the design is to utilize nanoscale emitters whose dimension is comparable to or smaller than the thermal wavelength, a regime when the Planckian energy distribution no longer holds. I will show my experimental and theoretical work to quantify the far-field thermal radiation from these rationally-designed nano-emitters. The result provides new insight into the realization of spatial and spectral distribution control for far-field thermal emission.

Biography:

Shin is an Assistant Professor in the Department of Mechanical Engineering at National University of Singapore (NUS). Prior to joining NUS, she received her Ph.D. in Materials Science and Engineering from UC San Diego in 2019. She specializes in experimental investigation of fundamental nanoscale heat transport for thermal management and development of personalized thermoregulators and energy harvesting devices using thermoelectric energy conversion. She is also the recipient of awards including, Global Young Investigator Award by ACerS (2022), MIT Technology Review Innovators Under 35 in Asia Pacific (2021) and UCSD Chancellor's Dissertation Metal (2020).

Solar Energy and Happiness Sentiment: The Pursuit of Sustainable Development under Impacts of Global Volatility

Nguyen Khac Quoc Bao[1,2] and Le Van[1,2,]

[1]Institute of Intelligent and Interactive Technologies (3I), UEH College of Technology and Design (UEH-CTD), University of Economics Ho Chi Minh City (UEH), Vietnam.

[2]School of Finance, UEH College of Business (UEH-COB), University of Economics Ho Chi Minh City (UEH), Vietnam.

Abstract

This study investigates the relationship between solar energy and happiness in the context of global volatility. In which, employ return series of the Ardour Solar Energy and Twitter's Daily Happiness Sentiment indexes and explore their nexus using the dynamic conditional correlation multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) framework from 14 October 2013 to 03 May 2022. We find statistically significant evidence that happiness positively

influences the performance of solar energy companies. In contrast, the solar energy index seems to negatively affect happiness. This finding implies the trade-off between happiness and solar energy development in pursuit of sustainability. This result is consistent when we consider two sub-periods, those are, stable economic conditions (from 14 October 2013 to 31 December 2019) and global volatility (from 01 January 2020 to 03 May 2022). In addition, the dynamic conditional correlation between return series becomes asymmetric under impacts of the global volatility, as initially caused by the Covid-19 pandemic. To further examine the relation between solar energy and happiness, we construct a pseudo portfolio including represented indexes. Our analyses affirm that the optimal weight of happiness increases in the second period. This effect suggests the optimal choice of happiness and sustainability in the context of global volatility. Accordingly, our findings recommend policy implications relating to the optimization of multiple objectives in pursuit of sustainable development goals.

Biography

Le Van is a PhD Candidate at University of Economics Ho Chi Minh City, Vietnam. Along the expertise of financial economics and public policy, he has been pursuing research in financial technology and sustainable development goals. Both researchers are core members of the 3I institute (UEH-CTD) and participating in technology and design projects.

Parallel Session-II

Fossil Energy |Environment & Pollution

Oral Presentations

Building Energy Modelling from CAD Tools

Emilio-José Sarabia-Escriva*, Víctor-Manuel Soto-Francés and José-Manuel Pinazo-Ojer

Universitat Politècnica de València, Spain

Abstract

Building Information Modelling methodology has meant a breakthrough in the exchange of information between the different participants in the building sector: architects, engineers, fabricants, facilities, managers and owners. Despite the advantages of this work methodology, its implementation has come up with some problems, most related to the interoperability between different applications. In most cases, technicians must define the geometry and add additional data to complete the energy-building model.

This work describes a new graphical compiler that allows describing the building envelope using 2D plans defined in CAD tools. Most professionals work with CAD applications with greater skill than with BIM due to the simplicity of the former. The CAD definition for the graphical compiler uses simple rules: polylines for defining zones, lines for defining windows/doors and texts (optional) for naming the different zones. All these elements must be defined in specific layers to be identified by the compiler.

This methodology is implemented in a software called “Genera3D”, and it allows generating of different BEM models: for a thermal loads software (CLIMA), for the official Spanish certification software (HULC) and for EnergyPlus (.idf files). The promoters of another Spanish certification software (CERMA) are interested in incorporating this definition in their software. Professionals have well received this procedure as it generates an automatic 3D thermal envelope of the model from a simple definition in 2D and saves time in the BEM definition.

Biography:

Emilio-José Sarabia-Escriva is an Assistant professor at Politechnical Universisty of Valencia (UPV). He teaches: Heat transfer, Cooling and Heating production, Air conditioning and Building energy efficiency. His research is focused on thermal modelling applied to different topics: building physics [10.1016/j.enbuild.2013.06.015, 10.1016/j.ijthermalsci.2013.07.024, 10.1016/j.ijheatmasstransfer.2015.04.110] and refrigeration and heat recovery [10.1016/j.ijrefrig.2019.08.005, 10.1016/j.apenergy.2020.114722, 10.1016/j.apenergy.2021.117799, 10.1016/j.tsep.2019.100386]. As a result of his research, it has been developed a varied software registered in the UPV and accessible from www.calculaconatecyr.com. He is a member of the technical committee of Atecyr (the Spanish version of Ashrae).

The Degradation of Pharmaceuticals by Hydrothermal Synthesis of CdS Sub-microspheres

Bushra Al Wahaibi*, **Zam Zam Al Rawahi and Rengaraj Selvaraj***

Sultan Qaboos University, Muscat, Oman

Abstract

Organic contaminants from industrial and domestic effluents may be harmful to humans directly or indirectly by degrading the quality of the aquatic environment. Consequently, these contaminants must be reduced to levels that are not harmful to humans and the environment before disposal. Conventional treatment methods exist for the removal of these pollutants from effluents. Among the available chemical methods, heterogeneous photocatalytic oxidation process has been found particularly effective in removing a large number of persistent organics in water. It has been well-known that under UV-visible light irradiation, nanostructured semiconductor metal oxides photocatalysts can degrade different organic pollutants. Taking into consideration of the photocatalytic activity, the present study deals with the synthesis of cuprous oxide (Cu_2O) particles by using three different methods such as solution phase, Microwave and Hydrothermal and characterized for their physicochemical, optical, and photocatalytic properties. The powdered X-ray diffraction (XRD) analysis confirmed for Cu_2O crystalline structure. The grain size of Cu_2O crystals were calculated by using Debye-Scherrer equation for Cu_2O (SP), Cu_2O (MW) and Cu_2O (HT) were found to be 50.40, 49.24 and 54.77 nm, respectively. The Field emission scanning electron microscopy (SEM) examined the morphology showed that the Cu_2O crystal are {100}-truncated rhombic dodecahedra, all-corner-truncated rhombic dodecahedra and rhombic dodecahedra. Furthermore, the prepared Cu_2O materials applied for the treatment of reactive red dyes present in aqueous solution. The Cu_2O samples exhibited good photocatalytic activity for the degradation of reactive red aqueous solution under visible-light illumination.

Biography:

Bushra Al Wahaibi is an Assistant Professor of Chemistry in the Sultan Qaboos University, Muscat, Oman with responsibility for teaching and research in the field of Analytical and Environmental Chemistry. Dr. Bushra Al Wahaibi graduated from Strathclyde University, UK with a PhD in Chemistry in 2012. He has 15 years of research experience in the area of human bioaccessibility of potentially toxic metals (PTE) in soil, water and food and environmental nanotechnology. She has published more than 10 research articles in reputed National, International Journals, and Proceedings.

The Contribution of Low Carbon Energy Technologies to Climate Resilience

Liliana Proskuryakova*

HSE University, Russia

Abstract

The UN vision of climate resilience contains three independent outcomes: resilient people and livelihoods, resilient business and economies, and resilient environmental systems. While changing energy systems is important, the transition to low-carbon technologies has to contribute to increased sustainability in other sectors and areas, taking into account the effects for human development. Solar, wind, geothermal, tidal, large and small hydropower, nuclear and other low-carbon power & heat plants vary in greenhouse gas emissions, amounts of required materials and minerals, volumes of water and space, the impact on wildlife and biodiversity. The study assesses the contribution of these technologies that are at various technology readiness level to climate resilience from the viewpoint of sustainable and human development. Methods used are based on

foresight and include horizon scanning and literature review, technology assessment, and expert procedures. The main outcome is the list of technologies that are ranked by their effects for climate resilience.

Biography:

Liliana N. Proskuryakova is Deputy Head and Leading Researcher at the Science and Technology Studies Lab at HSE University. Dr Proskuryakova specializes in energy studies, science and technology policy and international cooperation in research and innovation. She holds an MA degree in International Relations and a PhD in Political Science. Previously she worked as Head of Governance Unit at the UNDP Moscow Office and think-tanks. She also served as member of the Seoul Institute of Technology International Advisory Board, BRICS Russia Expert Council, Research Committee of the Russian National Committee of the World Energy Council, other expert bodies and foundations.

Emissions Budgets at Local Level

Vania Sena* and Ling Min Tan

University of Sheffield, UK

Abstract

The purpose of this presentation is to introduce a simulation model to capture emissions at local level (REBF). REBF has been proposed by Tan et al. (2021) and is a regional emission accounting and budgeting framework which aims to provide the evidence base to inform decisions on emission reduction measures. It combines a number of methodologies to track regional emissions and includes data collection, reporting inventory, projections of emission pathways, together with inventions and impact evaluation, as well as the implementation and review plan, in a single workflow to standardise the regional approach to emission auditing and carbon budgeting.

Geochemical Impact of Rock-Fluid Interactions during Hydraulic Fracturing in Marcellus Shale

Wei Xiong[1,2,*] , Hang Deng[3], Mengling Stuckman[1,2], Johnathan Moore[1], Dustin Crandall[1], J. Alexandra Hakala[1] and Christina Lopano[1]

[1]National Energy Technology Laboratory, USA; [2]NETL Support Contractor, USA; [3]Peking University, China

Abstract

The technology development of hydraulic fracturing in shale reservoirs resulted in significant opportunity for increased oil and gas production in the United States. Hydraulic fracturing involves injecting large volumes of fluids into the shale reservoir to increase permeability for shale gas extraction. Rock-fluid interactions can cause mineral dissolution and precipitation reactions that lead to permeability changes in the shale matrix, which ultimately may affect transport pathways and hydrocarbon production. Understanding the distribution of secondary precipitates, such as barite and Fe(III) (hydro)oxides, and cation leaching at the rock-fluid interface is an important step to further investigate how these geochemical processes can change permeability and transport pathways. The complex fracture passages can lead to local concentrated geochemical interactions, resulting in spatially variable scaling distribution. In this study, flow-through experiments using Marcellus shale cores with engineered flow pathways were done at hydraulic fracturing related conditions. Barite scaling mechanisms and Fe oxidation in the rock-fluid interface were investigated

via a series of techniques including X-ray CT imaging, synchrotron analysis, etc. Reactive transport modeling was conducted to support the experimental observations. The impact of rock-fluid interactions on hydraulic fracturing and shale gas production was discussed.

Biography:

Wei Xiong is a research scientist at National Energy Technology Laboratory. Her research focuses on understanding the geochemical impacts involved in subsurface energy systems and geologic carbon storage sites, using both experimental and modeling approaches. She currently leads multiple research tasks including topics on rock-fluid interactions during hydraulic fracturing in shale reservoirs, organic contaminants migration, novel strategies for carbon storage, geochemical signals to predict CO2 leakage probability for carbon storage. Dr. Xiong gets her Ph.D. degree in Energy, Environmental and Chemical Engineering from Washington University in St. Louis in 2017.

The Energy Sector and Green Infrastructure: A Data Science Study About Ecosystem Services and Respiratory Health

Luciene Pimentel da Silva[1,2]*, Murilo Noli da Fonseca [1], Edilberto Nunes de Moura [1] and Fábio Teodoro de Souza [1,3]

[1]Graduate Program in Urban Management (PPGTU), Pontifical Catholic University of Paraná (PUCPR), Curitiba 80215-901, Brazil

[2]Graduate Program in Environmental Sciences, State University of Rio de Janeiro, Rio de Janeiro 20550-900, Brazil

[3]KU Leuven—Faculty of Economics and Business (FEB), Research Center for Economics and Corporate Sustainability (CEDON), Brussels, Belgium

Abstract

The burning of coal, natural gas and oil for electricity is the largest single source of global greenhouse gas emissions to the atmosphere. Green infrastructure (GI) can reduce these impacts associated with the energy sector and provide ecosystem services, such as reducing energy consumption and air pollution dispersion, retain and promote infiltration of rainwater, as well as provide food, bioenergy and carbon uptake and storage, which provides means of climate change mitigation. These are all connected to many of the UN 2030 SDGs. This article presents a study about the ecosystem services of GI towards better respiratory health in a socioeconomic scenario typical of developing countries. It involves data science, comprising basic and multivariate statistical analysis, as well as data mining. The municipalities of the state of Paraná in Brazil were used as a case study. It consists of a cross-sectional study in which multiple data sets are combined and analyzed to uncover relationships or patterns. Data were extracted from national public domain databases. It was found that, on average, the municipalities with more area of biodiversity per inhabitant have lower rates of hospitalizations resulting from respiratory diseases. The biodiversity index correlates inversely with the rates of hospitalizations. It was also demonstrated the importance of socioeconomic issues in the environmental-respiratory health phenomena. The data mining analysis revealed interesting associative rules consistent with the learning from the basic statistics and multivariate analysis. The findings suggest that green infrastructure provides ecosystem services towards better respiratory health, but these are entwined with socioeconomics issues.

Biography:

Lecturer, works in the areas of hydrology, environment and urban systems. She holds a PhD in Civil

Engineering and Hydrology from Newcastle University, and a master's degree in Water Resources Engineering from COPPE / UFRJ. She was Assistant Coordinator between 2016 and 2018 of the Graduate Program in the National Network in Water Resources Management and Regulation (PROF-Água, Polo UERJ). Works with the initiatives of ClimateLabs (ERASMUS+) in measures to mitigate and adapt to climate change. She received a Jabuti award in 2016 in the category of Engineering Books, for "Hydrology, Engineering and the Environment".

Hydropower Controls Prototyping using Machine Learning

Mayank Panwar[1] *, Christopher van Hoecke[2], Bang Nguyen[1], Julian Osorio[1], Rob Hovsapian[1] and Chrys Chryssostomidis[2]

[1]National Renewable Energy Laboratory, Golden, CO, USA

[2]Massachussetts Institute Technology, Cambridge, MA, USA National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO

Abstract

Hydropower has been one of the largest clean energy generation and bulk energy storage for decades in the US electric grid. The recent push on the decarbonization goals, phasing out of fossil conventional generators, and integration of variable energy resources are presenting a new era of challenges for more dynamic operation of hydropower. This requires modernization and development of advanced control design and evaluation to address the integration and hybridization with electrical energy storage technologies. We present some aspects of addressing the abovementioned challenges through machine learning and controls prototyping approaches using actual hydro plant data and high-fidelity simulations considering multi-physical interaction of hydropower subsystems. The approaches are geared towards hydropower emulation for control performance validation under off-nominal scenarios for various design configurations and capacities of hydropower plants, including dynamic interaction with other bulk grid variable and inverter-based resources such as solar photovoltaics, wind energy, battery energy storage, and hydrogen-based technologies.

Biography:

Mayank Panwar is a Research Engineer with National Renewable Energy Laboratory in Golden, CO. He received his Ph.D. from Colorado State University in Ft. Collins in 2017. His research interests include real-time simulations, microgrids, hydropower controls, and machine learning

A Review on Janus Nanofluids in Petroleum Engineering

Wei Wang

Aramco Americas: Aramco Research Center-Boston, Cambridge, MA

Abstract

Applying nanomaterials in waterflooding is an emerging research topic in petroleum engineering research. Nanofluids, composed of nanoparticles (NPs) suspended in an aqueous solution, with or without the addition of other chemicals (surfactants or polymers), have received extensive interests by worldwide petroleum researchers because of their high potential for enhanced oil recovery (EOR) application. Various nanomaterials have been formulated and evaluated on EOR processes in laboratory scale experiments, which revealed the nanofluids as very promising agents for EOR. Janus nanoparticles (JNPs), as a new and special type of nanoparticles, have two or more

distinct surfaces which allow them to have different physical properties and chemical behaviors at the same time. In this presentation, the special features, synthesis methods, advantages and disadvantages of the Janus nanofluids for use in enhancement of oil recovery are reviewed. The effects of the Janus nanofluids on the wettability alteration, interfacial tension (IFT) reduction, and viscosity alteration on enhancement of oil recovery are analyzed. The challenges facing for use of the Janus nanofluids at field-scale operations are also discussed.

Large Scale Data Analytics for Resilient Energy Infrastructure

Chuanyi Ji[1]*, Amir Hossein Afsharinejad[1] and Robert Wilcox[2]

[1]Georgia Institute of Technology, USA; [2]National Grid, USA

Abstract

Severe weather events result in large-scale power outages, affecting millions of people in the US and the world. Such weather-induced power failures become increasingly frequent in a changing climate. This calls for a resilient energy infrastructure. However, the lack of comprehensive and detailed failure data as well as analytics has impeded large-scale resilience studies. This work studies the resilience of energy infrastructure using the data collected from the distribution grid across multiple US service regions in the states of New York and Massachusetts. Our data analytics is guided by non-stationary random processes and unsupervised learning. Our analysis shows that a local failure has non-local impact on customers, as shown by a 20-80 scaling law that reflects vulnerability of the distribution grid [1]. Recovery that favors large failures counters such infrastructure vulnerability, where about 80-90% of the customers recover in 10-20% of interruption durations [2]. However, the prioritized recovery degrades significantly with respect to the severity of weather events.

Our study demonstrates that data analytics is capable of obtaining new and insightful knowledge on the resilience of energy infrastructure and services. Importantly, the data we use are commonly available to most distribution grid operators in the US and parts of the world. Thus, our communities have the ability to turn data into knowledge for enhancing the resilience of the energy infrastructure.

[1] Ji et. al. *Nature Energy*, vol. 1, no. 5, p. 16 052, 2016.

[2] Afsharinejad et al., *Joule Cell Press*, vol. 5, no. 9, pp. 2504–2520, 2021.

Biography:

Chuanyi Ji's research is in large-scale data analytics, networks and machine learning. With her students and collaborators, Ji has developed large-scale analytics for the resilient energy infrastructure, using grid data from seven major service regions across the US. The studies have been published at leading energy journals such as Joule and Nature Energy. Chuanyi Ji received the B.S. (Honors) from Tsinghua University in 1983, the M.S. from the University of Pennsylvania in 1986, and the Ph.D. from the California Institute of Technology in 1992. She is an Associate Professor at Georgia Institute of Technology USA, which she joined in 2001.

Modelling of the Thermal Processing of Additive Manufactured IN718

Magnus Anderson*, Prashant Jadhav and Hector Basoalto

The University of Sheffield, United Kingdom

Abstract

This presentation provides details about recent advances in the modelling of precipitation and homogenization kinetics during the solid solution treatment and aging of additive manufactured IN718, produced using powder bed selective laser melting. This manufacturing route results in unique microstructures, with high amounts of chemical segregation that incurs anomalous precipitation kinetics. Conventional solid solution treatments applied to cast or wrought material result in unsatisfactory microstructures when applied to additively manufactured components. A one-dimensional multi-component model of diffusion has been coupled with a statistical multi-phase model of precipitation. The model has been applied to predict precipitation kinetics during homogenization treatment and determine the volume fraction of precipitates during aging. The model is successful in predicting the dissolution of phases during solid solution treatment and provides a useful tool for the design and optimization of thermal processing of nickel-based superalloys.

Biography:

Magnus Anderson is a lecturer in Metallurgy at the University of Sheffield, working within the multi-scale materials modelling team. His research interests include understanding and predicting the evolution of far-from equilibrium microstructures during manufacture and service, developing composition dependent location specific predictions of microstructure and properties. He specializes in statistical modelling of solid-state precipitation utilising chemical thermodynamics The models developed have passed key technology readiness levels within industry and have won international awards for predictive capability.

Building Management System BMS as a Modern, Intelligent Building Management System for Zero-energetic Object Smart Building

Monika Gwóźdź - Lasoń *

University of Bielsko-Biala, Poland;

Abstract

The publication discusses Building Management System. BMS it's building automation system that gives the ability to monitor and manage all devices and systems located in the building and its surroundings. The proposed models and algorithms for managing lighting, heating, air-conditioning or alarm installations, enables more convenient and more effective use, and even to transform a typical building into a smart house. An intelligent home has set a new direction in creating comfortable business, housing or industrial spaces in a sustainable way. The zero-energy object is equipped with a number of ecological solutions managed by BMS, which allows you to reduce energy and water consumption and CO_2 emissions, while maintaining high user comfort. The building uses an intelligent heating system IHS, which is based on ground and air heat pumps, depending on the needs of heating or cooling the object. Electricity is produced using photovoltaic panels, and the surplus is sold to the city network. Additional savings are generated by automatic regulation of artificial lighting taking into account the amount of natural light and movement of people indoors. Usable water in the building is heated by solar collectors. The BMS control system also includes meteorological conditions, such as outside temperature, wind speed, rainfall or the degree of sunlight and optimizes the factors inside the object. The integrated air-control system is responsible for comprehensive cleaning and filtration of air from particles, biological pollution and takes care of the most optimal temperature level, relative humidity air and concentration. New characteristics of a building need a suitable model and management algorithm for a construction investment, which is presented at work.

Keywords: Construction; Building Management System; Smart Building; Construction design; econometric model;

Sustainable Methods of Cultivating and Processing Microalgal Biomass from Wastewater to Produce Various Renewable Industrial Bioproducts.

Venkatesh Balan

Department of Engineering Technology, College of Technology, University of Houston, Sugar Land, TX

Abstract:

Microalgae are microscopic photosynthetic prokaryotic or eukaryotic organisms that naturally grow in fresh or marine water in the presence of sunlight. Algae are capable of sequestering nutrients from water and accumulate them as their body mass. Additionally, microalgae's ability to fix large amounts of CO_2 has led researchers to investigate microalgae as an alternative way of combating climate change by sequestering flue gas containing CO_2 emitted from industries. This presentation will focus on sustainable methods of cultivating and processing microalgal biomass from wastewater to produce various renewable industrial bioproducts including biogas. First, different methods of microalgae cultivation, harvesting, separation, and processing techniques to aid the microalgae biotechnology industry's ability to economically produce sustainable bioproducts while reducing carbon emissions will be discussed. Second, the possibility of producing algal biomass in three large wastewater treatment facility in Texas will be presented. Third, the sequestration of CO_2 produced during combustion of biogas producing algal biomass using Rotating Algal Biofilm (RAB) methods will be discussed. Finally, a model to study the conversion of algal biomass produced in small water treatment facilities in Texas to various bioproducts (bioethanol, biosuccinic acid, biodiesel, biocrude, Non-Isocyanate Polyurethane Foam (NIPU), and mixed alcohols) will be presented. Developing methods of using algal biomass as feed stock producing renewable bioproducts will displace fossil fuel derived products, generate new jobs and benefit the environment.

Biography:

Venkatesh Balan is an Associate professor at Engineering Technology Department at College of Technology, University of Houston since September 2017. His research is concentrated in Biomass conversion to fuels, chemicals, edible mushrooms, animal feed and biomaterials. Other area of expertise including developing genetically engineering micro algae to produce bioplastics and biochemical from greenhouse gases (CO_2), value addition to mushroom industrial waste and annotating fungal genes to identify novel enzymes for industrial application. He has published over 181 publications, awarded 9 patents with >15,000 citation to his credit and edited couple of books related to biomass conversion and microbial lipids. He also has served as an expert reviewer for numerous scientific journals and served in several scientific review panels.

The use of Benzoxazine Resin to Reduce the Water Blockage and Increase Gas Deliverability

Gonzalo Mauricio Ceron Lopez[1]*, Matthew B. Mayers[2], Quan Xie[1], Colin D. Wood[2] and Ali Saeedi[1]

[1]Curtin University, Kensington, Australia

[2]CSIRO, Australian Resources Research Centre, Australia

ABSTRACTS

Abstract

The latest events associated with the shortage of hydrocarbons in Europe in early 2022 generated a drastic increment in the gas price until mid-2022. Additionally, gas has been playing a substantial role as a transition energy source from fossil fuels to clean energies. Therefore, an important productivity issue in gas reservoirs, that is primarily associated with strong water-wet condition presenting significant capillary forces that retain water in near wellbore area after exposure to an invasive fluid, is denominated water blockage. A number of mitigation techniques have been proposed and applied where only few presented temporary results. More effective and permanent results have been obtained by wettability alteration through chemical treatment. So far, many researchers have focused on the application of fluorinated compounds to alter rock wettability. However, those chemicals are expensive and bio-accumulate. The aim of this research project is to evaluate the application of a novel economic and environmentally friendly benzoxazine resin to alter rock wettability as a water blockage permanent treatment. Experimental results have demonstrated an increment of up to 20% in the relative permeability to gas and a reduction of up to 10% in the residual water saturation caused by the benzoxazine resin treatment over the rock surface. It would lead to a noticeable improvement in gas mobility. In addition, wettability alteration has been observed during contact angle and spontaneous imbibition test, demonstrating the effectiveness of our chemical treatment in improving gas productivity using an economic and environmental friendly chemical compound.

Retail Motor Gasoline Prices and Mortgage Loan Interest Rates

Balbinder Singh Gill

Stevens Institute of Technology, United States

Abstract

I study how retail motor gasoline prices in a certain area impact the interest rates on mortgage loans used to buy homes in the same area in the United States for the period from 2008 until 2021. I find that retail gasoline prices lower the cost of home loans. Property buyers avoid purchasing a mortgage-financed home in areas with higher fuel costs to avoid risking their own future mortgage repayments due to potential purchasing power loss due to increasing gasoline prices. After resolving possible omitted variable concerns and disentangling the influence from trends in local cost-of-living and local housing prices, the findings remain unchanged. The introduction of alternative fuels cannot eliminate the negative impact of gasoline prices since the cost for motor gasoline customers to move from motor gasoline to alternative fuels remains significant.

Biography:

Balbinder Singh Gill is a tenure-track Assistant Professor of Finance at the School of Business at Stevens Institute of Technology. He holds a Ph.D. in finance from Temple University. His doctoral dissertation was about the finance and politics of disaster loans. Professor Gill's primary areas of research are climate finance, fintech, political economy of finance, and real estate finance. His work has been presented at several major conferences, including the annual meetings of the American Economic Association, American Finance Association, and the Financial Management Association. He currently teaches sustainable finance and international business at Stevens Institute of Technology.

Accelerating Urban Road Transportation Electrification: Planning and Implementation Strategies

Ata M. Khan* and Junshen Feng

Carleton University, Canada

Abstract

Urban governments are keen on road vehicle electrification in support of sustainability goal. Among many strategies, the charging availability is commonly recognized as a key enabler to accelerate the electrification process. At the outset, this paper describes the planning and implementation challenges to socially acceptable and cost-effective transition of passenger light duty vehicles to electrification. These vehicles, used for personal and shared mobility, account for about one-third of an urban area's greenhouse emissions. Three facets of the charging availability strategy are covered next, with emphasis on socio-technical factors. The first facet calls for new policies and regulations that will remove hurdles to electrification. Urban governments need policy and regulatory tools so as to encourage EV charging at gas stations and parking lots within the overall climate emergency action plan. An example is the City of Vancouver's by-law that calls for gas stations to develop the capability for electric vehicle charging. A second set of strategic actions covers incentives to expand charging infrastructure. Innovations underway are cited that include exploration of partnerships with the private sector to expand infrastructure. Conditions favourable to gas station conversion in the UK and USA are noted, including business models facilitated by public agencies. The third set of strategic actions encompasses technical challenges in integrating technologies and streamlining installations. Technical topics covered include changes to the electricity distribution grid so as to accommodate the impacts of DC fast charging stations. In the last part of the paper, conclusions and recommendations are presented.

Biography

Ata M. Khan is a professor emeritus in Civil and Environmental Engineering at Carleton University, Ottawa, Canada. His research interests focus on intelligent systems, automation in driving, policy and planning, and safe, efficient, and sustainable transportation. He has carried out research/consulting projects for the United Nations; federal, provincial, and municipal governments in Canada; and private sector companies/societies in the USA, Japan, and Canada. The co-author of the paper, Junshen Feng, received his B.Eng. (Civil) degree from Carleton University. He is working on his Master's thesis on the subject of methodology to estimate the need for fast chargers in urban travel corridors.

Bioeconomy Delivering Sustainability

Jhuma Sadhukhan*

Professor of Energy, Environment and Chemical Engineering, University of Surrey, UK

Abstract

Climate change impact, biodiversity loss and critical resource depletion are the three grand challenges, the world is facing today. My research and education endeavors aim to address these global grand challenges through the whole system life cycle sustainability assessment encompassing technical, environmental, economic, social and cultural pillars, and circular renewable bioeconomy, which are essential to meet the net zero (neutralization of climate change impact), biodiversity

and circular economy (critical resource security) challenges. My plenary will show renewable and bio-based sustainable activities for net zero, circular economy, green inclusive growth and intensification of bio-based production and consumption pathways. Waste resources (or biomass feedstocks) are mapped, and constraints are determined to reinforce the need for a robust simulation and analysis framework and flexible agile integrated circular bioeconomy systems. It will show integrated biorefinery configurations utilizing locally available renewable and waste resources into multiple added-value products, nutraceuticals, pharmaceuticals and personal and home care products, biofuel, nutrients or feed, heat, and electricity, etc. While the high-value economic margin generating products only take up <10 wt% of dry ton biomass feedstocks, the bulk of the feedstocks is available for energy products to achieve net zero. The optimal integrated sustainable biorefinery configurations can be derived from "superstructure" and climatology and waste biomass characterization analyses. My plenary will highlight the challenges of developing our fundamental understanding of how and when to implement circular bioeconomic systems and at what geographical and policy scales.

Biography

Professor Jhuma Sadhukhan, a Fellow of the Institution of Chemical Engineers, has a PhD in Process Integration from The University of Manchester. With industrial experience as a Process Systems Engineer at MW Kellogg Ltd. and Technip Ltd., she has eighteen years of academic experience (Surrey and Manchester Universities, UK). Her current grants span tech metal circular economy, energy system optimization, hydrogen economy, and bioenergy/bioeconomy policy. She serves on Nature and Elsevier journals' Editorial Boards. She has authored 168 peer-reviewed journal publications including the only authored book in the biorefinery/bioeconomy field and supervised 20 PhDs and 25 Post-Doctorates through to completion

Energy Efficiency: Economic use of Compressed Air in Pneumatic Conveying for Bulk Solids

A.G. Freitas[123*], V.F. Oliveira[4], R.B. Santos[5], L.A.M Riascos[1], S. Kuang[3], R. Zou[3] and A. Yu[3]

[1] Department of Energy/Federal University of ABC (UFABC)

[2] Department of Engineering and Informatics/University of Bradford, UK

[3] Lab for Simulation and Modelling of Particulate Systems (SIMPAS)/Monash University, AU

[4] Polytechnic School/University of São Paulo, BR

[5] Zeppelin System Latin America, BR

Abstract:

Pneumatic conveying of powders is an engineering process used for conveying dry granulate or powder material. In this research, we focus on energy efficiency to reduce Operational Expenditure (OPEX). Work was conducted to model pneumatic conveying and bulk characteristics of the particulate product being conveyed. Because pneumatic conveyance is highly empirical, general models are difficult to establish. Due to these limitations, evaluating energy efficiency is usually limited to a specific experimental range of conditions. This work is based on engineering optimization of a workflow with data from an industrial operation commanded by a Programmable Logic Controller (PLC) with a control algorithm, performing logical, sequential, and timed tasks for plant control. The PLC communicates with a Human-Machine Interface and a Supervision and Control System, which are the means of interaction through a graphical environment interface with the process operator. By applying mathematics to introduce a systematic method to select the gas (air) pressure and flow necessary to operate a pneumatic conveying system in dense

phase, it has been shown, on an industrial scale, the feasibility of controlling a conveying system manipulating only two input parameters. This allows operation at pre-determined conveying rates with lower power requirements and OPEX. The same methodology can be explored for several other pneumatic conveying systems.

Key words: Energy efficiency; Optimization; Pneumatic conveying; Solid feeder.

Biography:

Visitor PhD scholar at Laboratory for Simulation and Modelling of Particulate Systems (SIMPAS), at the Department of Chemical and Biological Engineering, Monash University/Australia. Exchange PhD candidate at Department of Mechanical and Energy Systems Engineering, University of Bradford, Bradford/United Kingdom. PhD candidate at the Energy Program, Federal University of ABC, Santo Andre/Brazil. Mr. Adriano has worked with engineering teams from a German company to make optimization projects that will be further developed in order to allow better understanding of the interaction between materials conveyance, operational variables and the relationships through energy efficiency in heavy equipment.

Facilitated Transport Membranes for Low Cost Decarbonization

Christine Parrish*, Sudip Majumdar, Ken Loprete and Nic Renard

Compact Membrane Systems Inc. Newport, DE

Abstract

Separations account for 45-55% of the total industrial energy use in the United States. To decarbonize the production of vital chemical building blocks before irreparable damage to the environment is done, emissions of hard to abate chemical processes must be decreased. Compact Membrane Systems (CMS) has developed a platform of breakthrough facilitated transport membranes for deep industrial decarbonization. Membranes have long held promise for reducing the energy intensity of these processes but previously no membrane had sufficient chemical stability for commercial scale up and adoption. This talk will discuss the fluoropolymer chemistry and engineering innovation that has enable the commercialization of CMS' Optiperm™ membranes: olefin paraffin separation and post combustion carbon capture.

For olefins, we will discuss the first commercial demonstration of a facilitated transport membrane in our work with Braskem. We will discuss both the scaling process of lab to commercial membrane cartridges and system design considerations for proper operation.

For carbon capture results have shown a very high flux membrane (1000-3000 GPU) with adequate selectivity (15-30) at realistic conditions that would result in substantially lower capture costs and increased efficiency. The membranes attain this performance at elevated temperature (60-100°C) and in the presence of poisons (SOx and NOx). Results from the aging and poison testing will be discussed. The full system design includes a two-stage cascade approach to decrease the energy use while maintaining 90% CO2 recovery and 95% CO2 product purity. Design considerations and cost sensitivities for operating conditions will be discussed for three use cases.

1 Sholl, D.S., Lively, R.P., Nature, **532**, 435-437, 28 April 2016

Biography

After completing her degree in Chemical and Biomolecular Engineering from the University of Delaware, Christine joined Compact Membrane Systems in research development for their facilitated transport membranes. Over the last five years she has developed her expertise in membranes for a variety of separations and system design and modelling. She currently serves on the leadership team and is the Business Development and Product Strategy Lead for CMS to enable their deployment of post combustion carbon capture membranes.

Electronic Structure Analysis of a Novel Magnetic Tunnel Junction Device Fe/LiF/MgO Interface Based on the First-principles Calculations

Takuya Sekikawa *, Kazuki Takada and Yoshiaki Ōno

Niigata University, Japan

Abstract

Recently, Nozaki et al. have developed a new magnetic tunnel junction device consists of Fe/LiF/MgO interface so as to improve the perpendicular magnetic anisotropy (PMA), where the Fe magnetization perpendicular to the interface is stabilized by inserting an ultrathin LiF layer of atomic scale 0.1~0.6 nm at the Fe/MgO interface. X-ray magnetic circular dichroism measurements have revealed that the ultrathin LiF insertion increases the orbital-magnetic-moment anisotropy and enhances the PMA. Theoretically, first-principles calculations have been performed for Fe/LiF and Fe/MgO interfaces to study tunneling magnetoresistance and magnetocrystalline anisotropy, respectively, but not for Fe/LiF/MgO interface so far. The purpose of this paper is to study Fe/MgO and Fe/LiF/MgO interfaces on the basis of the firstprinciples calculations and to discuss effects of the ultrathin LiF insertion. For the Fe/MgO interface, we use a slab model consists of 8 atomic layers of MgO and 8 atomic layers of Fe. For the Fe/LiF/MgO interface, we use a slab model consists of 8 atomic layers of MgO, monolayer of LiF and 8 atomic layers of Fe. Based on these slab models, we investigate the electronic states and discuss in particular effects of the LiF insertion. We also calculate the spin state of the Fe layer based on the non-collinear DFT method and discuss the enhancement of PMA due to the monolayer LiF insertion.

Biography:

Takuya Sekikawa is a third-year doctoral student of the Graduate School of Science and Technology, Niigata University and is supported by Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists. He is working on condensed matter theory in Ōno's group, especially focusing on the electronic state and the superconductivity based on the first-principles and quantum many-body calculations.

Future Nuclear Energy Use in Japan -Analysis of LWR long-term Utilization Scenarios

Kenji Takeshita

Tokyo Institute of Technology, Japan

Abstract

Assuming scenarios for the sustainable nuclear power generation until the middle of the 22nd century, which include technical options related to nuclear power generation, reprocessing, partitioning-transmutation and geological disposal, the scenario analysis using a dynamic nuclear fuel cycle simulator NMB4.0 was carried out. Based on the results of the future scenario analysis, it was shown that the timing and effects of the introduction of technology options for nuclear power generation, reprocessing, partitioning & transmutation, and geological disposal toward the second half of the 21st century. These results are expected to be utilized as basic data for the discussions on future nuclear energy policies and R&D policies.

Partitioning and Transmutation of MA for Sustainable Use of Nuclear Energy

Tatsuro Matsumura

Japan Atomic Energy Agency, Japan

Abstract

The use of nuclear energy is necessary to achieve carbon neutrality and sustainable use of energy. In order to sustainably use nuclear energy, it is important to reduce the environmental burden through the disposal of radioactive waste and to efficiently use uranium resources. Efficient use of uranium resources can be achieved by utilizing plutonium, which is produced from uranium in nuclear reactors. However, since this spent fuel contains a large amount of minor actinides, its long-term radio-toxicity and heat generation would be a significant environmental burden in geological disposal. Therefore, we are developing partitioning and transmutation technology to separate minor actinides from high-level liquid waste that remains after uranium and plutonium are recovered by reprocessing, and to transmute them into short-lived and stable nuclides. In this presentation, the effect of the separation of minor actinides will be described, and the results of research and development on chemical processes to separate minor actinides to achieve this will also be presented.

Biography:

Tatsuro Matsumura is the deputy division head of JAEA and also works as a visiting professor at Tokyo Institute of Technology. He specializes in nuclear chemistry, actinide chemistry, and separation process chemistry. Recently, he has been studying the environmental impact of radioactive waste disposal and the effect of radionuclide separation on it. He also has a strong interest in the effects of the use of nuclear energy on the sustainable use of energy.

A Quantification of Classic but Unquantified Positive Feedback Effects in the UrbanBuilding-Energy-Climate System

Yukihiro Kikegawa*

Meisei University, Japan

Abstract

The interaction between urban air temperature (*T*) and building cooling energy demand (*E*) generates a well-known positive feedback (PFB), which is mediated by sensible anthropogenic heat (Q_{fs}) and named Q_{fs}-*T*-*E* PFB in this study. This PFB could induce self-reinforced warming in urban areas, but its effects have not been quantified. Hence, this study aimed to clarify these effects by targeting Osaka, a Japanese major city. Focusing on the from-weekends-to-weekdays increase in urban energy consumption including *E* increase as an observable trigger of the PFB, its induced *T* rise due to growth in Q_{fs} was estimated with the fed-back additional *E* gain on weekdays based on observed ground-level *T* and district-wise electric power consumption during summer. The result indicated that the weekdays–weekends contrast in energy consumption over Osaka could induce the PFB effects, which resulted in fed-back *E* gain reaching 10% on weekdays. Such observational PFB impact on *E* was found to be roughly reproducible by the proposed urban meteorological model, named WRF-CM-BEM. Thus, the validated model was applied to the simulation of the climatological PFB impact on *T* based on feedback gain (g_A) which means a percentage of *T* variation caused by the PFB. The simulation provided estimates on g_A, whose daytime averages reached nearly 10% in the downtown commercial areas and 20% in the leeward-located residential areas.

Such estimated impacts on T seemed to be non-negligible, considering the feedback impacts on global surface warming estimated with g_A of approximately 50% by the Intergovernmental Panel on Climate Change.

Biography:

Yukihiro Kikegawa (https://scholar.google.co.jp/citations?user=raOUgdUAAAAJ&hl=ja) is a professor in the field of urban climatology and thermal environmental science at Meisei University in Tokyo. He received B.S. and M.S. degree in Geophysics from Tohoku University, and Ph.D. degree in Engineering from the University of Tokyo. His main research interest is in the interaction between climate and human activities especially in urban areas. He has been developing his original model which can simulate the urban-building-energy-climate system.

Pumped-hydro Environmental Problems

Glen Currie

The University of Melbourne, Australia

Abstract

When we consider Biodiversity and Invasive Species, Erosion and Sedimentation and Water Quality issues the track record of hydro projects is poor. In this research, I delved deeply into the planned project Snowy 2.0 in Australia. It is in a National Park, which creates risk and I uncovered that: one hundred sq km of the Kosciusko National Park will need to be cleared permanently for the Snowy 2.0 transmission connections; four million tonnes of rock will be excavated and may introduce acid-forming minerals in the river system. Snowy 1.0 excavated similar rock and may have contributed to eradicating almost all fish in the Tooma River; and that the stocky galaxias fish is vulnerable to extinction despite netting at the outlet proposed by Snowy 2.0.

The Nonlinear Relationship Between Entrepreneurship and Natural Resource Rents

Nguyen Phuc Canh

Sangho Kim and Su Dinh Thanh

Abstract

To examine a nonlinear relationship between entrepreneurship density and natural resource rents, we apply the Panel-Corrected Standard Errors (PCSE) estimator to a sample of 87 countries over the period of 2006–2016. We find strong evidence of the nonlinear relationship between the two variables. The influence of entrepreneurship density on natural resource rents is subject to two different regimes. In low- and upper-middle income countries, an increase in entrepreneurship density increases natural resource rents to a certain level, but it reduces the rents afterwards. In high-income countries, the relationship is reversed. Policymakers should adapt their entrepreneurship policy to prevailing economic circumstances to enhance economic sustainability.

Keywords: Entrepreneurship; natural resources; rent seeking; panel data

JEL Classification Codes: C23; D73; L6

Investigation of Ammonium Carbamate-based SCR System to Achieve Heavy-duty Low NOx Targets

Hassan Raza[1, 2*] and Hongsuk Kim[1, 2]

[1]University of Science and Technology, Republic of Korea

[2] Korea Institute of Machinery & Materials, Republic of Korea

Abstract

Increasing stringent emissions legislation required the exhaust gas after-treatment systems (EATS) to be developed effectively. Currently, the urea water solution (UWS) based SCR system being commercially used for NOx reduction poses issues like low deNOx performance below exhaust gas temperature of 200°C and deposit formation inside the exhaust line. Here we report on a study of an ammonium carbamate (AC)-based SCR system, which supplies gaseous ammonia into the SCR to reduce NOx emissions from heavy-duty diesel engines. The possibility of injecting gaseous ammonia at an exhaust gas temperature of below 200°C without deposition problem makes it a superior alternative to UWS. The NOx conversion efficiency of the AC-based SCR system was more than the state-of-the-art UWS system. The NOx conversion efficiency of AC in the World Harmonized Transient Cycle (WHTC) and Non Road Transient Cycle (NRTC) was increased compared with that of UWS during the cold phase by 6.43% and 8.71%, respectively, and during the hot phase by 14.79% and 11.93%, respectively. To achieve the heavy-duty low NOx targets different strategies were used. Model-based injection of ammonia was found to be useful to increase the cold start NOx conversion efficiency. By increasing the NH_3/NOx (α)ratio an increase in deNOx performance was observed. However, in the case of AC, due to the ammonia gas injection at an exhaust gas temperature of below 200°C the N_2O emissions were increased compared with UWS injection. The N_2O emission was increased proportionally with increasing the ammonia injection amount.

Biography

Hassan Raza is a Ph.D. student of Mechanical Engineering at the University of Science and Technology (UST), Daejeon, South Korea, and working as a research assistant in the department of Mobility Power Research of Korea Institute of Machinery and Materials (KIMM) since 2018. He received a B.E. in mechanical engineering from the University of Engineering and Technology (UET), Lahore, Pakistan in 2017 with a distinction of Gold Medal. His research interests and activities as a researcher include environment-friendly vehicles and exhaust gas after-treatment systems of IC engines.

A Case for Data and Analytics Modernization

Kevin Monte de Ramos

Innovation Columnist for CLIMATE & ENERGY, Canada

Abstract

Over the decades, program offerings related to climate and energy have advanced significantly; ultimately, becoming more and more data-driven. Smart thermostats were the first bidirectional devices able to inform occupants of opportunities to reduce energy consumption and to offer insights directly to its users. We seem the same integrated feedback built into cars, building spaces, lighting controls, household appliances, and more when commercial processes are considered. In this presentation, a case will be made for data and analytics modernization to assure advance our offerings. With many programs and applications being built upon a cloud-based architecture, utilities

and their regulators will need to enable investments in this type of technology architecture if we are to move forward at the pace sought by the United Nations and the governments participating in The Paris Agreement. For good reasons, utility investments lag those being implemented by energy service providers and other innovators active within climate and energy. We will explore where we are today, what is likely tomorrow, and the investments needed to realize our ambitions. In this session, Kevin will lead an interactive session that contextualizes the data and analytics infrastructure upon which our programs operate, and the interoperability challenges that impede policy direction.

Biography:

Kevin Monte de Ramos is a well-tenured management consultant guiding utilities and other energy service companies to better manage the finite resources available within their jurisdiction. Today, he serves as Innovation Columnist for the on-line magazine CLIMATE & ENERGY with a subscriber base of over two million. Kevin found his way into the utilities industry by following emergent data and analytics capabilities from his origins as a breast cancer researcher. His familiarity with the scientific method allowed Kevin to introduce data-driven efficiencies into program designs, operational processes, and methods to assess both intended impacts and unintended consequences.

Role of Energy Consumption on the Environmental Impact of Sectoral Growth in Malaysia

Kizito Uyi Ehigiamusoe[1]*, Marina Mustapha[2], Sotheeswari Somasundram[2] and Hooi Hooi Lean[3]

[1]University of Southampton Malaysia, Johor, Malaysia;

[2]Taylor's University Malaysia, Selangor, Malaysia;

[3]Universiti Sains Malaysia, Penang, Malaysia

Abstract

Though some studies have investigated some determinants of environmental degradation, the factors that influence the components of ecological footprint (i.e., built-up land, cropland, carbon sequestration land, fishing ground, grazing land, and forest land) have not been thoroughly explored. Besides, the moderating roles of renewable and non-renewable energy on the impacts of population and GDP on ecological footprint have not been empirically unveiled. These issues are fundamental to the actualization of the Sustainable Development Goals (SDG-7, SDG-8 and SDG-13). Thus, our study fills these research gaps, and makes contribution to the extant literature by using panel data of low-income countries, a group of economies often neglected in empirical analysis. It employs the extended STIRPAT (Stochastic Impacts by Regression on Population, Affluence and Technology) model, as well as empirical techniques that control endogeneity, heterogeneity, and cross-sectional dependence. Our study shows that GDP and non-renewable energy aggravate ecological footprint while renewable energy mitigates it. The study further unveils the effects of these variables on different components of ecological footprint. Moreover, the study indicates that renewable energy has a favourable moderating role on the impacts of population and GDP on ecological footprint, while non-renewable energy has a detrimental moderating role. The economic implications of the findings and policy options for sustainable production and consumption are analyzed.

Biography:

Kizito Uyi Ehigiamusoe is Assistant Professor of Economics in University of Southampton Malaysia. He obtained his Ph.D from the Universiti Sains Malaysia (USM) under the USM Fellowship Award.

His main research areas include Energy Economics, Financial Economics and Macroeconomics. He has published several articles in reputable journals such as Journal of Travel Research, Journal of Sustainable Tourism, International Journal of Finance and Economics, Journal of Cleaner Production, Journal of Policy Modeling, Applied Energy, Renewable and Sustainable Energy Reviews, etc. He has presented several papers in international conferences and secured some research grants. He serves as Editor/Referee for reputable journals.

Treatment of Produced Water with Photocatalysis: Recent Advances, Affecting Factors and Future Research Prospects

Huiyao Wang*, Lu Lin, Wenbin Jiang and Pei Xu

New Mexico State University, USA

Abstract

Produced water is the largest byproduct of oil and gas production. Due to the complexity of produced water, especially the dissolved petroleum hydrocarbons and high salinity, efficient water treatment technologies are required prior to beneficial use of this waste stream. Photocatalysis has been demonstrated effective to degrade recalcitrant organic contaminants, however there is limited understanding about its application to treating produced water that has a complex and highly variable water composition. Therefore, the determination of the appropriate photocatalysis technique and the operating parameters is critical to achieve the maximum removal of recalcitrant compounds at the lowest cost. The objective of this review is to examine the feasibility of photocatalysis-involved treatment for removal of contaminants in produced water. Recent studies revealed that photocatalysis was effective to decompose recalcitrant organic compounds but not for mineralization. The factors affecting decontamination and strategies to improve photocatalysis efficiency are discussed. Further, recent developments and future research prospects on photocatalysis derived systems for produced water treatment are addressed. Photocatalysis is proposed to combine with other treatment processes such as biological treatment to partially reduce TOC, breakdown macromolecular organic compounds, increase biodegradability, and reduce the toxicity of produced water.

Biography:

Huiyao Wang studied Physics at the Lanzhou University, Lanzhou, China and graduated as MS in 1993. He then joined the research group of Prof. Tianmin Wang in the Department of Material Science at the Lanzhou University. He received his PhD degree in 1998 at the same University. After two years postdoctoral fellowship and several research associate works, he obtained the position of an Associate Professor at the New Mexico State University. He has published more than 50 research articles in SCI journals.

Applications of Nanomaterials in Developing Filtration Reducers and Plugging Materials for Drilling Fluids

Lili Yang*, Yongwei Zhang and Hanqing Liu

National Engineering Research Center of Oil & Gas Drilling and Completion Technology, China

Abstract

The performance of drilling fluid directly affects the success or failure of drilling. That's why it

is called the "blood" of the drilling process. However, excessive loss of drilling fluid, especially leakage, not only causes the loss of drilling fluid and delays the drilling cycle, but also causes sticking, well collapse, kick and even blowout accidents, contaminates oil and gas formations, causing significant economic losses. On the other hand, the temperature and salt resistance of drilling fluid poses a severe challenge as the drilling depth increases. Inorganic nanomaterials have the advantages of small size and good anti-temperature ability, and have been widely used in many fields. In our study, nanomaterials were introduced to develop a series of excellent drilling fluid additives, including filtration reduction agents and plugging materials. The results show that the inorganic nanomaterials grafted with polymers on the surface can resist 240 °C and saturated salt, while the introduction of inorganic nanomaterials into plugging materials can produce plugging materials with high strength and self-healing capacity and resist 150 °C. All these materials cause no significant viscosity increase in drilling fluids, and their main mechanism is the reasonable particle size distribution and surface chemistry of particles, which greatly improve the denseness of mud cake during filtration and plugging layer during leakage. This study demonstrates the advantages of using nanomaterials to develop high-efficiency drilling fluid additives that are expected to be applied in the field.

Biography:

Lili Yang is mainly engaged in the field of oilfield chemistry and reservoir protection related theories and technologies in oil and gas, geothermal and gas hydrate exploitation. She has published more than 50 papers, and holds 5 Chinese patents and 1 US patent, presided over funds from the National Natural and Science Foundation of China, National Science and Technology Project. Dr. Yang was honored with the Youth Top Talent Award of CUPB. She is now a member of youth editorial board of Petroleum Science and a reviewer of several journals.

Application of Machine Learning Techniques to Predict Viscosity of Polymer Solutions for Enhanced Oil Recovery

Mariam Shakeel[1]*, Peyman Pourafshary[1] and Muhammad Rehan Hashmet[2]

[1]Nazarbayev University, Kazakhstan

[2]United Arab Emirates University, United Arab Emirates.

Abstract:

Polymer flooding has become one of the most developed and implemented enhanced oil recovery (EOR) techniques. The principal controlling factor in polymer flooding is the viscosity of the polymer solution which helps to lower the mobility ratio and improve sweep efficiency. However, designing a polymer solution's viscosity is both time and resource-intensive task as several parameters need to be designed to maintain the desired polymer viscosity such as brine salinity, polymer concentration, temperature, etc. This study aims to find a quick method to determine the viscosity of three polymers namely DPTLB-2070, SAV-10, and SAV-333 polymers as a function of the critical parameters of shear rate, polymer concentration, and temperature. Four different data analysis techniques have been applied including multiple linear regression (MLR), support vector machine (SVM), regression decision tree (RDT), and artificial neural network (ANN). The results show that MLR is not suitable to predict polymer viscosity because of the non-linearity of the problem. Among the machine learning methods, the ANN model having 2 hidden layers and five neurons in each layer has provided the best results with an R-squared of around 1.0 for training, validation, and testing datasets in the case of all three polymers.

Biography:

Mariam Shakeel is a Ph.D. researcher in petroleum engineering department, Nazarbayev University, Kazakhstan. After completing B.Sc. Petroleum Engineering in 2014, she joined the petroleum industry and spent a year working as a production engineer for Schlumberger Pakistan. She then worked at Orient Petroleum Limited in Islamabad, Pakistan, until August 2019. Mariam opted to pursue research in the area of enhanced oil recovery after gaining five years of practical exposure, and she enrolled at Nazarbayev University as a master student in 2019. She has a strong research aptitude, as evidenced by several articles she has published in impact-factor international journals.

Energy Applications

The Role of Community Energy to Facilitate Energy Transitions in Ethiopia, Malawi, and Mozambique

Mulualem G. Gebreslassie*

Mekelle University, Mekelle, Ethiopia

Abstract

Energy transitions is getting considerable interest from policymakers and the academiainthequest to achieve affordable, modern, sustainable and green energy for all. This is beingdrivenby a combination of the lack of electricity access to millions of people particularly in theAfricancontinent and the requirement for the reduction of environmental impact through theuseof greener energy resources and systems. The research presented here is a summary of aninterdisciplinary research programme that is attempting to understand the operationandimpacts of community energy systems in the quest to facilitate energy transitions inEthiopia, Malawi and Mozambique. This paper focuses on the progress made so far, the opportunities, and challenges in the development of community energy systems. This is achievedthroughsystematic review of recent national and international publications, official energy policies andregulations, and interviews with community energy managers. The findings indicate that community energy developments are predominantly basedonrenewable energy resources, which is one of the pathways required to a cleaner energygeneration. However, the pace of community energy development in these three countriesisslow. The key reasons include but not limited to: lack of conducive regulatory frameworks, vague definition of community energy, lack of clear financing mechanisms, weak commitmentsfrom all stakeholder, lack of greater community involvement etc. with a varying degreeinthethree countries. These key issues are hindering the contribution of community energy systemsin driving the necessary energy transitions to a cleaner, modern and affordable energy systems.

Biography:

Gebreslassie is an Associate Professor of Renewable Energy at Mekelle University. Hehasover 17 years of extensive leadership, project management, research and teaching experiencein the energy sector. He has been and is currently involved in several national and international collaborative research and capacity building projects worth of multi million dollar as principal and co-principal investigator with more than 37 international Universities and companies . Hiswork focuses on renewable energy development, project management, Grid andoff-gridenergy systems, energy transitions, energy conservation and management, and energy policy.

Personalized Option-based Energy Trading for Enhancing Household Pro-environmental Behaviors

Xu Qian [1*] and Bon-Gang Hwang [1]

The University of Lincoln, UK

Abstract

The growth in urbanization and the time humans spend indoors significantly contributes to excessive building energy consumption worldwide. Especially in the post-Covid-19 pandemic era, more

ABSTRACTS

people are working from home, which further increases the energy demand in residential buildings. Energy-saving behavioral interventions are, therefore, essential to counter the consequence of soaring energy demand among households. However, the large-scale deployment of occupant energy behavioral interventions, such as providing rewards to encourage energy-saving behaviors, requires continuous financial inputs, which has been a particular challenge and financial burden to energy authorities. Market-based energy-saving interventions provide a potential solution, as they have low cost and long-term impacts on reducing energy consumption.

This study aims to (1) develop a trading platform integrated with a personalized feedback loop, (2) investigate the effects of the option-based strategies on household energy reduction, and (3) examine the household behavioral changes. Derived from binary options, our option-based energy-saving strategies provide households opportunities to earn monetary rewards, depending on whether they achieve the pre-determined energy-saving goals at the due date. The preliminary results show promising energy savings (up to 12.56% energy reduction) and pro-environmental behavioral changes induced by the option-based strategies and these strategies were welcomed by the residents. The findings of this study shed light on the impacts of energy conservation interventions that leverage the concept of options in the financial market and provide a baseline for future option-based intervention explorations. In addition, it equips policymakers with deep insights into household energy behavioral changes induced by energy behavioral interventions.

Biography:

Xu Qian is a research fellow in the Department of the Built Environment at the National University of Singapore. Her current research interests include green finance, project risk management, occupant energy behaviors, and building energy savings.

Computation of Energy Efficiency of Edible and Non-edible Oil Recovery under Linear and Non-linear Processes

Abraham Kabutey

Czech University of Life Sciences Prague, Czech Republic

Abstract

The 21st century has seen high demand for energy production due to the increasing depletion of fossil fuels, population growth, industrialization, urbanization and rise in vehicles production. Globally, energy efficiency and climate protection are of crucial importance to economic growth, social development and human survival. Governments, stakeholders, scientists and researchers are working on policies and strategies as well as embarking on continuous scientific research to achieve a sustainable energy-efficient future in an environmentally friendly world. In linear and non-linear environments, energy efficiency refers to the maximum oil output with minimum energy input and negligible residual oil when dealing with the technologies for processing the feedstocks. The edible and non-edible oil-bearing crops (soya, rape, sunflower, oil palm, coconut, etc) are among the first-generation feedstocks for biofuel production. The processing technologies involve both the traditional systems (hydraulic and screw presses, etc) and advanced methods (pressurized liquid extraction, microwave-assisted extraction and ultrasound-assisted, etc). The advanced techniques are usually employed in the developed countries, and they provide greater reliability, but with high production cost compared to the traditional methods which are used in developing countries providing low oil yield and being time-consuming. The traditional oil extraction methods can be described as linear and non-linear processes where the operating factors (moisture content, pressure, temperature, heating time, speed, nozzle sizes, screw sizes and cylinder mesh sizes) need to be evaluated for their

optimal levels for maximum oil output with minimum energy input by using appropriate statistical, modelling and optimization techniques.

Biography:

Abraham Kabutey is an Associate Professor of Technique and Mechanization in Agriculture at the Faculty of Engineering, Department of Mechanical Engineering, Czech University of Life Sciences Prague (CULS), Czech Republic. Dr Kabutey's research is focused on the mechanical and rheological properties of agricultural materials and products (plant fibres and residues, oilseeds, vegetables, fruits) useful for designing and developing energy-efficient processing systems. Dr Kabutey has a keen interest in global energy efficiency strategies (renewable energy sources) against climate change mitigation. Dr Kabutey has published considerable publications indexed in both Scopus and Web of Science with H-index of 10 (without self-citations).

The Next Generation of Fast Charging Methods for Lithium-Ion Batteries: The Natural Current-Absorption Methods

T.G. Thusitha Asela Bandara*

University of Oviedo Gijón, Spain

Abstract

The fast charging of Lithium-Ion Batteries (LIBs) is an active ongoing area of research over three decades in industry and academics. The objective is to design optimal charging strategies that minimize charging time while maintaining battery performance, safety, and charger practicality. The main problem is that the LIB technology depends on multi-disciplinary engineering factors that form rapidly varying intrinsic states in the cell during the charging process. These factors take the form of interdependent electrochemical, structural, and thermo-kinetic perspectives. Here, the list can grow as electrochemical changes; charge transfer, ionic conductivity, structural transformations; mass transfer, diffusion, and thermo-kinetic exchanges; phase transitions, heat effects, and collectively their inter-dependencies. Fast charging intensifies this varying nature making it very difficult to achieve an optimal process. Also, many charging strategies fail to adopt such rapid variations and are based on predefined parameters such as voltage, current, and temperature, individually or collectively, that enforce and aggregate stress on the LIBs. Consequently, fast charging accelerates battery degradation and reduces battery life. To facilitate the design of optimal fast charging, this paper analyzes the literature around the influences of intrinsic factors on the LIB charging process under electrochemical, structural, and thermo-kinetic perspectives. Then, it examines the existing charging strategies with a new categorical analogy of; 1) memory-based, 2) memory-less, and 3) short-cache, showing their efforts to achieve optimal charging targets and challenges. Accordingly, a potential paradigm shift for the next generation of LIBs' fast-charging strategies has been identified in the new area of short-cache-based natural current-absorption-driven charging strategies.

Biography:

Bandara, holds a PhD in computer science from the University of Grenoble Alpes – France 2018, specializing on fast charging LIBs based on non-linear voltammetry (NLV) based adaptive charging with AI and ML on battery analytics. He has two patents ("PCT/IB2018/059756" & "PCT/IB2018/059766") for a battery-charging software protocol, which fully charge a Li-Ion battery in around 20 minutes (a very significant reduction in charging time compared to existing charging techniques), and also a provisional patent in Singapore for Fast Charging LIBs. His current research interests include fast-charging, modeling and characterization of rechargeable LIBs, Blockchain, ML, and IOT.

A Sustainability Assessment of a District Heating System's Development Pathways: A Hybrid Model of System Dynamics and Multi-criteria Analysis

Jelena Ziemele*, Janis Edmunds Daugavietis and Elina Dace

University of Latvia, Latvia

Abstract

Climate change and geopolitical situation substantially affect the development of energy systems and a district heating system (DHS) as part of it. Currently, developing a DHS that provides transition towards the 4th generation DH (4GDH) and achieves deep decarbonization is especially topical for policymakers, DH providers and consumers in the EU at regional and local levels.

A system dynamics (SD) model is developed in this study to analyse the causal influence of the three main factors that significantly influence the transition of the current DHS towards 4GDH: (1) resources that are available to the DHS, (2) conversion and/or exchange technologies, and (3) change in the final demand. In the model, these factors are dynamically and simultaneously analysed to capture the interlinked and interacted energy flows. Several pathways are proposed where effects of industrial heat pumps, solar systems, and waste heat integration in a multi-generative DHS are assessed as compared to an existing DHS that is based on biomass and natural gas combustion technologies. The simulation results from the SD model are used as techno-economic, environmental, and social indicator values in multi-criteria analysis (MCA) for the sustainability assessment of the developed pathways. The hybrid model provides results that rank the selected transition pathways according to their sustainability score and thus serves as a guidance to DHS developers and decision makers. The case of Riga city in Latvia is presented in the study.

Biography:

Jelena Ziemele is an international level energy professional, expert and project manager. She has more than 25 years of experience grounded by theoretical (PhD in Environmental Engineering) and practical experience in private, public and academic sectors. In recent years, she has been involved in projects and research on transition of DH towards 4th generation systems with near zero emissions.

MoS2-based Nanocomposites for Water Decontamination and Metal Recovery

Ines Zucker*

Tel Aviv University, Israel

Abstract

Contamination of drinking water sources by a variety of organic and inorganic compounds demands more efficacious and reliable treatment technologies. However, conventional water treatment technologies remain chemically demanding, energy intensive, and ineffective in removing key trace contaminants. In addition, the increasing industrial demand for precious metals in the last decades results in consideration of recycled resources to balance between energy consumption and cost-effectivity. Nanotechnology-based approaches hold great potential to enhance or replace traditional remediation and recovery methods because of the high reactivity and tunable-properties of nanomaterials. In her talk, Dr. Zucker will provide an overview on the current status of nano-enabled technologies in the water-energy nexus, including promising opportunities and barriers for implementation. Specifically, the application of molybdenum disulfide (MoS_2) for heavy metal removal and recovery will be extensively discussed as a case study, where material properties, removal mechanisms, and large-scale applications are optimized.

Biography

Ines Zucker holds a B.Sc. degree in Mechanical Engineering, M.Sc. degree in Materials and Nanotechnologies Engineering, and Ph.D. in Materials Science and Engineering with expertise Environmental Engineering, all from Tel-Aviv University. Alongside these diverse educational experiences, Ines completed her postdoctoral training at Yale University at the field of environmental applications and implications of nanotechnology. Ines now serves as a jointly-appointed senior lecturer (assistant professor) in the School of Mechanical Engineering and Porter School of Environmental Studies. Using a wide skill-set combining material sciences and environmental engineering, the ZuckerLab focuses on advanced materials and novel approaches for environmental applications, alongside with environmental and health impacts of nanotechnology.

Multiphysics Modeling and Economic Analysis of a Novel Heat Engine Configuration

Abhishek Kumar Singh* and Jordy Hofsink

University of Twente, The Netherlands

Abstract

An ever-increasing percentage of power is generated through renewable sources such as solar PV or wind turbines. The inherent intermittency of these sources makes the power supply from renewables unstable. A novel system is proposed in which excess electricity generated through renewables is converted to heat and stored. When needed, the heat is converted back to electricity using the highly efficient Alkali Metal Thermoelectric Converters (AMTEC) ensuring grid stability. These solid-state energy converters are highly efficient, and scalable, possess no moving parts, and operate similarly to an idealized Carnot cycle. They have a faster response time in comparison to conventional turbomachinery-based systems. A novel combined cycle is proposed consisting of an AMTEC topping cycle in combination with an organic Rankine cycle (ORC). A Multiphysics model is developed to simulate and analyze the performance of the proposed novel heat engine configuration. Parametric optimization is performed to achieve optimal system performance. The proposed AMTEC/ORC achieved a maximum power density of 0.98 W/cm2 and a maximum conversion efficiency of 40%. Next, the novel heat engine configuration is subjected to economic analysis. Through the economic analysis, the competitiveness of the novel heat engine in the current market is analyzed. The Levelized Cost of Electricity of the heat engine is calculated, and a sensitivity analysis is performed to find which cost parameters have the largest impact on the system LCOE. The LCOE of the proposed power-heat-power cycle is found to range from 88.8 to 129.29 $/MWh.

Biography:

Abhishek Kumar Singh is an Assistant Professor in the Department of Thermal and Fluid Engineering at the University of Twente, the Netherlands. He completed his Ph.D. in Mechanical Engineering from the University of Florida, Gainesville. He also performed research at the German Aerospace Center, Colorado School of Mines/ NREL, and Georgia Tech. His research includes the development of thermal systems for heat storage, solar fuels, CSP, industrial heating, and carbon capture and utilization. His current and previous research is funded by US- DOE and EU projects. He is also a recipient of the prestigious Marshall Plan Foundation and DAAD-DLR Postdoctoral Fellowships.

Fabric Supercapacitor for Solar Energy Storage

Jonathan Y. Chen*

The University of Texas at Austin, USA

Abstract

Development of smart wearable technologies is soaring. A challenge arisen from this market competition is new power supply format that could be interfaced by wearable products to support integrated electronic units. Traditional battery and supercapacitor products are limited to satisfy the new application need, because most battery/supercapacitor constructions are still a rigid format based on metal, carbon, and liquid electrolyte, less related to flexible textile fabrics. This presentation introduces an all-fabric supercapacitor (FSC) as an energy storage device for solar energy harvesting. The developed technology is based on highly porous and conductive fabrics together with a solid-state electrolyte to form a flexible fibrous architecture of supercapacitor. This presentation will illustrate FSC structural features, and report evaluation results of FSC electrochemical and mechanical properties, in terms of cyclic voltammetry (CV), galvanostatic charge/discharge (GC), electrical impedance spectroscopy (EIS), capacitance retention, and tensile and tear strengths related to device durability. As a summary, the presentation will exhibit potential FSC end uses in apparel, sports, leisure, and other consumer products.

Biography:

Jonathan Y. Chen, Full Professor in the Texas Materials Institute at The University of Texas at Austin, has expertise in structure, process, evaluation, and applications of renewable and polymeric fiber materials and fabric composites. His current research focuses are on biobased functional fiber and fabrics for sustainable and smart textile applications. He has published over 120 research papers in peer-reviewed journals, books, and technical conference proceedings. Dr. Chen is Fellow of The Textile Institute and Senior Member of The American Association of Textile Chemists and Colorists. He is serving on the editorial board of Journal of Industrial Textiles.

Large-scale Building Performance Modeling to Evaluate the Impacts of Emerging Technologies on Mitigating Climate Change

Liping Wang*

University of Wyoming, Laramie, WY

Abstract

Buildings account for 40% of the total energy consumption in the U.S. The effects of climate change have further increased energy usage and peak demands of buildings. The overall goal of this study is to quantify the effects of emerging technologies, such as indoor greenery systems and radiative cooling building materials, on mitigating climate change using large-scale building performance modeling. This research involves creating an integrated large-scale building energy modeling framework to enable large-scale building energy predictions under future climate scenarios at the community levels; the large-scale building energy modeling is then used to evaluate the impacts of emerging technologies, such as radiative cooling materials and indoor greenery systems, on mitigating climate change.

Biography:

Liping Wang is an Associate Professor (Tenured) in Civil and Architectural Engineering at the

University of Wyoming. Her research interests are in the areas of building performance modeling, fault detection and diagnosis for HVAC systems, energy efficiency for indoor agriculture, and resource-efficient and resilient urban systems. She is an Associate Editor for the Journal of Sustainability Technologies and Assessment (Elsevier) and Guest Editor for the Journal of Energy and Buildings. Her research projects were sponsored by National Science Foundation, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the U.S. Department of Energy, and the U.S. Department of Agriculture.

Renewable Energy Powered Sustainable Internet of Things

Lina Pu

University of Alabama, Tuscaloosa, AL

Abstract:

Internet of Things (IoT) is the technology that will transform our world in the coming years. IoTbased devices are now ubiquitous (e.g., smartphone, smart TVs, sensors, etc) in terrestrial, and will expand to the underwater world. Energy supply raises critical challenges with the dramatic device growth. To meet the ever-increasing need on energy supply, energy harvesting is envisioned as a promising alternative to power the numerous low-power devices and sensors. In this talk, Dr. Pu will report her explorations of efficiency and security in RF energy harvesting wireless communication network. First, she will discuss how to efficiently manage the harvested energy for information transmission. Afterwards, she will introduce her recent work on the malicious energy attack in energy harvesting wireless networks.

Biography:

Lina Pu is currently an Assistant Professor in Department of Computer Science at University of Alabama. Before joining UA, she was an Assistant Professor at University of Southern Mississippi. She received her Ph.D. degree from the Department of Computer Science and Engineering, University of Connecticut, in December 2015. Dr. Pu's research interests include, but not limited to: cybersecurity, sustainable and secure IoT, and deep learning enabled wireless networks. Dr. Pu has published more than 40 papers in prestigious journals and international conferences. She was the recipient of the Best Paper Award of IFIP Networking 2013 as the first author. She has been serving as TPC members and technical reviewer for dozens of journals and international conferences as well.

Theoretical Modeling and Computations of New Materials for Electrochemical Energy Conversion and Storage Devices

Jingsong Huang*, Jacek Jakowski, Panchapakesan Ganesh, and Bobby G. Sumpter

Oak Ridge National Laboratory, Oak Ridge, TN

Abstract

As the world is facing a growing demand for energy and an adverse impact of fossil fuels on environment, new materials for electrical energy conversion and storage technologies are constantly developed to harness sustainable and renewable energy resources. In this talk, we will present a review of our theoretical modeling and computations of new materials in the past fifteen years for electrochemical energy conversion and storage devices. We will showcase our theoretical studies of 1) various carbon nanomaterials based endohedral and exohedral supercapacitors, 2) various

anode and cathode electrode materials and electrolytes for lithiumion, sodium-ion, and lithium-sulfur batteries, and 3) various electrocatalytic reactions including nitrogen fixation, hydrogen evolution, oxygen reduction, and carbon dioxide reduction. Our efforts span modeling, simulation, and theory, through experimental data analysis, database mining, machine learning, and density functional theory calculation. We will focus on the materials structures, the physical and chemical processes, and particularly the energy conversion and storage mechanisms at the electrode-electrolyte interface. The fundamental understandings thus obtained can provide deep insight that may help scientists to further optimize new materials toward practical technology applications.

Biography:

My initial background was experimental organic chemistry and physical chemistry, with some experiences in chemical industry. I started to embark on theoretical and computational studies of physical and chemical problems of functional materials from 1999. Research experiences are mainly the modeling/simulation/theory of structure-property correlation, weak intermolecular covalent bonding interactions, and electrical energy conversion/storage. With a background of an experimental chemist and expertise of a theoretical and computational chemist, my primary goal is to establish the bridge between experimental observations and theoretical rationalizations, which is further used to guide material discovery and experimental optimization.

Multiscale Modelling of Battery Electrolytes

Naga Neehar Dingari* and Kaustubh Badwekar, Vamsi Garapati, Mahesh Mynam and Beena Rai

TCS Research Center, India

Abstract

Lithium (Li) ion batteries are one of the best energy storage device technologies due to their high energy density and long cycle life. Despite these advantages, the current generation Li ion batteries suffer from issues related to safety and reliability and need a significant improvement to meet the growing energy storage demands, especially in the electric-vehicle sector. The performance of a Li ion battery depends strongly on the battery materials used and in the recent past researchers have devoted significant effort to come up with better battery materials. Allied Market Research predicts that the global market for battery materials will reach USD 80.5 billion by 2030.

Electrolyte is a battery material that plays a crucial role in ensuring safe and reliable operation of the battery. Electrolyte transport properties such as ionic conductivity and diffusivity play an important role in minimizing internal heating, enabling fast charging and ensuring long cycle life of the battery. Traditional way of optimization of the electrolyte composition relies heavily on experimental methods and trial and error. With the advent of computational modelling techniques and HPC infrastructure, in-silico methods have gained a lot of importance as powerful tools for large scale screening, design and optimization of materials. At TCS Research, we use physics based multiscale methods to study the transport properties of electrolytes at molecular level and use these insights to study their impact on system level battery performance. This enables efficient screening and optimization of electrolyte composition and facilitates design of batteries with improved performance.

Biography:

Naga Neehar Dingari is a Scientist at TCS Research, Pune. He received PhD degree in Mechanical Engineering from Massachusetts Institute of Technology (2017) and bachelor's and master's degrees in Mechanical Engineering from Indian Institute of Technology, Kharagpur (2011). His research interests include microfluidics, biomechanics and energy storage devices. Over the last five years, his work at TCS has received significant interest from clients across various industrial sectors and has led to a collaborative research project with a leading pharma company. He has 8 journal papers, 5 patent applications, 1 granted patent and has presented his work at various conferences.

Energy Efficient Pathology on a Portable Spinning Disc

Neha Gautam * and Arnab Sarkar*

Indian Institute of Technology (BHU), India

Abstract

Traditional blood related pathological diagnostics are not only costly but also consumes high power. Herein we propose a low cost portable spinning disc for studying blood rheology exploiting centrifugal and Coriolis forces on the rotational microfluidic platform. We load 10 µl of blood sample and bloodplasma separation can be accomplished using centrifugation of the spinning disc with minimum rpm where combined influence of centrifugal as well as Coriolis force plays a vital role while selecting optimal rotational speed and duration of rotation. Owing to the density gradient different cellular components of blood such as red blood cells, white blood cells and platelets are appearing in different regions of the rotating disc where image processing can be carried out through a smart phone app leading to the count of different cellular components. On the other hand, for different serum tests 10-20 µl reagent is employed followed by a reaction with the analyte to detect the concentration of the same through colorimetric technique where colorimetric analysis is being carried out through Image J software which can easily be integrated in smartphone. After separating serum, we will let the same to be reacted with new generation material matrix leading to the oxidation or reduction where peaks can be identified through electrochemical sensing in screen printed electrode. In a nutshell, our aim is to determine the concentration of different minerals in serum in a smart phone integrated platform from sample-to-result integration via single step with the engagement of minimally trained human resources.

Biography:

Arnab Sarkar received two gold medals in his Master of Mechanical Engineering at Jadavpur University for being a topper in the department as well as in the faculty of engineering and technology. He was also a DAAD Doctoral Fellow at Ruhr-University Bochum Germany from 2007-2009. He is currently working on the medical application of fluid mechanics leading to energy efficient medical diagnostics, which results in publications in highly cited journals. He has published 31 articles in SCI/SCIE journal and investigated 15 projects so far. Neha Gautam is a doctoral student at the Indian Institute of Technology (BHU), Varanasi, India. Her research interest includes microfluidics, electrochemical sensing and energy efficient pathological diagnostics.

Materials Research for the Energy Transition: From Modelling to Small Scale Systems

Anja Bieberle-Hütter*

Dutch Institute for Fundamental Energy Research (DIFFER), The Netherlands

Abstract

At DIFFER, we focus on materials, processes and systems for the energy transition. We do this by experiments and modeling. In this presentation, I want to focus on three, unique approaches:

1. Combination of plasmolysis and solid oxide electrolyser cell technology in order to split CO_2 and make the products available for chemical industry or as aviation fuel. We will present results on the understanding of the CO_2-to-CO plasmolysis, material development and proof-of-concept of O_2 removal under $CO_2/CO/O_2$, up to the development of a container-sized unit.
2. Combination of methods from control theory and system identification with microkinetic modeling in order to identify the limitations at electrochemical materials and interfaces. This approach allows us not only to simulate the same data that is experimentally measured, but also enables to identify reaction mechanisms, validate electrochemical models, and predict data that cannot be easily measured.
3. Combination of Machine Learning and database development with materials processing and characterization in order to accelerate materials development and screening.

Biography:

Anja Bieberle-Hütter studied Materials Science & Engineering at the University Erlangen-Nürnberg, Germany, and Alfred University, USA, and holds a PhD from ETH Zurich, Switzerland. After several years in industry and at Massachusetts Institute of Technology (MIT), USA, she worked as a senior scientist, Oberassistent, lecturer, and project manager at ETH. Since 2014, Dr. Bieberle is leading the group "Electrochemical Materials and Interfaces" at DIFFER (Dutch Institute for Fundamental Energy Research) and acts as the head of the Solar Fuels department since 2020.

Her research focuses on experiments and modeling of materials for the energy transition. She is a renowned international expert represented in numerous (inter)national commissions/boards.

First Principles Investigation on Pristine and Transition Metal Doped WSe2 Monolayer as Promising Photocatalysts for Water Splitting

Celine Wu* and Xuan Luo

National Graphene and Research and Development Center, Springfield, VA

Abstract

Photocatalytic water splitting is a promising renewable energy source as an alternative for limited fossil fuels. The effectiveness of the conversion from solar energy to hydrogen fuel relies primarily on the material. Previously, researchers studied different TMDs such as WS2, and PdSe2. These materials perform well in certain aspects such as strong adsorption stability and promising abilities for HER, however, their band gaps are still not ideal. In this paper, we studied a new TMD material WSe2, which is currently used in heterostructure photocatalysts. To our knowledge, this is the first assessment of using transition metal doped WSe2 as potential photocatalysts for photocatalytic water splitting. Using first principles calculations, we evaluated the band gaps and other photocatalytic abilities of pristine WSe2 as well as Cr, Mo, Ta, and Re doped WSe2. Compared to previously studied TMD materials, three of our newly studied materials (pristine, Mo doped, and Ta doped WSe2) demonstrated more desirable band gaps, which are closer to being ideal (1.23eV); The band edge positions of our materials are also closer to the ideal reduction potential of H+ / H2 and the oxidation potential of O2/H2O. Furthermore, Mo and Ta doped WSe2 monolayers undergo an exothermic process, indicating stable monolayers. Of the three selected materials, pristine WSe2 exhibits the strongest water adsorption abilities. Our results substantiate pristine, Mo doped, and Cr doped WSe2 as potential photocatalysts for water splitting.

Biography:

Celine Wu is a senior at Montgomery Blair High School in the STEM Magnet program. Celine won first place in the Maryland Junior Science and Humanities Symposium (JSHS) for her research with Dr. Xuan Luo. Celine also has received numerous awards in science, math, computer science, and public speech. For example, Celine was a national finalist for the American Computer Science League competition. Besides academics, Celine is also the business manager and a senior writer for her school's newspaper, a 6-time regional (MD, DC, VA, DE) volleyball champion, and a 2nd place winner at the US Girls Junior Volleyball Nationals.

Spray Flash Processes: New Technologies for Sustainable Energy Materials

Denis Spitzer*, Anna K. Ott, Marc Comet, Guillaume Thomas, Guillaume Galland and Guillaume Direur

NS3E (Nanomatériaux pour les Systèmes Sous Sollicitations Extrêmes), France

Abstract

Whether for energetic materials, batteries, photocatalysis applications, new formulation and synthesis processes that imply vacuum spray are nowadays revolutionizing many key domains such as health, security and energy transition. These new technologies are essential to produce breakthrough nanometric and submicron-sized materials of sufficient quality and quantity. The talk will focus on the description of two formulation and synthesis processes conceived and studied at the NS3E laboratory: the Spray Flash Evaporation (SFE) process for formulation and the Spray Flash Synthesis (SFS) process for chemical synthesis. The presentation will in particular insist on the versatility of pure and composite materials accessible with SFE and SFS, but also on the wide scope of applicative domains covered. After describing the two processes, different materials previously designed and produced by both processes are highlighted. These materials include organics such as energetic materials and more efficient active pharmaceutical ingredients, but also different inorganic materials for fuel cells, photovoltaic, and superconductor applications. Due to the recent character of both processes, different cutting-edge metrologies, optimized used to investigate them on a fundamental aspect, are addressed. These metrologies are used in real-time (ex. Phase Doppler Particle Analysis) during the functioning of the processes or in an off-line manner (ex. AFM-Tip Enhanced Raman Spectroscopy) to characterize the obtained products. Different examples of real-time solvent droplet sizes and velocities analyses to understand the spray processes will be shown. In the case of the off-line material analysis, examples of structural material characterization on nanoscale level will be highlighted.

Biography:

Denis SPITZER received his PHD in physical chemistry in 1993 at the University of Strasbourg. He conducts research in continuous formulation and synthesis processes of organic, inorganic and organic/inorganic nano- and submicron sized materials such as energetic materials and materials for the energy transition. He is the inventor of the SFE and SFF processes. He received in 2013 the award of strategic thinking given by the French Homeland Minister, in 2015, the « Grand Prix Lazare Carnot » award of the French Academy of Science, and in 2022, the CNRS Innovation Medal.

Supported Vacuum-insulations - A Highly Efficient Structure for Applications in Energy-storage Devices

Jobst H. Kerspe

Dr. Kerspe GmbH, Germany

Abstract

Evacuated insulation-layers are well known for their very good insulation characteristics – but mostly they are expensive (because of the high vacuum), fragile and can only be manufactured in round-shaped bodies. Supported vacuum-insulations in GVI®-technology have best insulations-characteristics too, are strong and rigid like a honeycomb structure. They can be designed and manufactured in nearly every dimension and shape – even as flat panels.

GVI® is a hybrid composite structure: the (vacuum-tight) envelope is made from thin stainless steel – the supporting filler-material in the insulation-gap is micro-porous such like a highly compressed mineral- fiber or silica powder. While evacuating the gap to a mild vacuum, envelope and filler are pressed together and thus generate a light-weight honeycomb-structure with its good mechanical and thermal properties.

Today such structures are applied as housings for high efficient heat storages (or even cryogenic tanks), multifunctional battery-housings in electric cars as well as in composite wall systems for highly efficient buildings. One aspect in all these applications is the multifunctionality: GVI® is the thermal insulation as well as a housing that can withstand high mechanical stress

The GVI® technology with its main features will be explained in this presentation and examples from different applications will be shown.

The Effects of Carbon Taxation on Electricity Price Dynamics: Empirical Evidence from the Australian Market

Nicola Comincioli[1,2*], Mattia Guerini[1,2] and Sergio Vergalli[1,2]

[1]University of Brescia, Italy

[2]Fondazione Eni Enrico Mattei, Milan, Italy

Abstract

In this paper, we focus on the Australian carbon tax by studying the effects that its introduction and subsequent repeal had on the Australian national electricity market. We find that the carbon tax exerts a relevant negative effect on electricity price's volatility. To study the dynamics of electricity price's volatility, we fit a two-states Markov Switching Model, representing a high- and a low-volatility state of the world. Estimation results highlight that, in periods where the tax applies, the volatility level for both states of the world is reduced. Furthermore the persistence in the low-volatility state is increased by the presence of the carbon tax. Finally, our results suggest that the repeal of the tax had pernicious effects on Australian electricity prices' volatility. Our result are particularly relevant also for macroeconomic considerations. Higher uncertainty of electricity prices can be a crucial determinant of firms' investment decisions as well as for the formation of inflation expectations.

Biography:

Nicola Comincioli is researcher at the Fondazione Eni Enrico Mattei (FEEM) in Milan and research fellow at the University of Brescia. He holds a M.Sc. in finance and a Ph.D. in economics, both from University of Brescia. His main research interests are energy economics (quantitative approach and real option modeling applied to resources and energy markets) and public economics (stochastic modeling in corporate and/or green taxation). Nicola has also been visiting student/researcher at the Walton College of Business (USA), Macquarie University (AUS) and Massachusetts Institute of Technology (USA).

Exploring Future EV Charging and Home Heating Solutions using a Responsible Approach to Research and Innovation

Christopher R. Jones

University of Portsmouth, United Kingdom

Abstract

The social acceptability and acceptance of energy sector innovations is important for their real-world, commercial success. Failures to recognize, understand and integrate the opinions of social stakeholders (including affected publics) can negatively affect the ability of innovations to secure funding, find suitable sites for deployment or gain regulatory approval. Responsible research and innovation (RRI) is an ethical way of developing new ideas (including technological R&D) that recognizes and harnesses the social as well as the commercial benefits of the innovation process, and ensures that any harm to the social and physical environment is avoided or minimized. This presentation will outline details of RRI before showcasing two active, interdisciplinary projects focused on energy sector innovation that are seeking to employ an RRI approach. The first project, *GasNetNew*, is exploring innovative ways of utilizing the mains gas network to offer alternative, low-carbon home-heating and cooling solutions. The second project, *FEVER*, is developing a new, off-grid, renewably-powered electric vehicle (EV) charging solution. Both projects have significant contributions from social scientists and are seeking to engage and empower social stakeholders to shape the R&D process. This presentation will give a candid appraisal of the initial success (or otherwise) of these projects in achieving their RRI goals.

Biography:

Jones is an Associate Professor in Applied Psychology at the University of Portsmouth, UK. He is an expert in the social acceptability and acceptance of energy-related technologies, and has published research on myriad supply-side (e.g., renewables, CCUS, fusion, fission) and demand-side (e.g., smart-home technologies) technologies. He has a BSc (Hons) in Psychology (University of Birmingham, UK, 2002), an MSc in Psychological Science (University of Sheffield, UK, 2003) and a PhD in Social Psychology (University of Sheffield, UK, 2007). He is a named Co-Investigator on the *GasNetNew* (EP/W008726/1) and *FEVER* (EP/W005883/1) projects.

Investment Analysis for Low-carbon Building Retrofit with EF-EC Energy-economic Performance Prediction Tool for Deep Energy Retrofit

Ke Qu*, Yuhao Wang, Tianhong Zheng and Saffa Riffat

University of Nottingham, United Kingdom.

Abstract

In the UK, 79% of residential building stocks are dominated by single-family houses, of which roughly 54% are constructed before the 1970 s with poor energy efficiency. However, few studies have addressed the issue of return rate on investment for deep energy retrofit in single-family houses over the past decades.

The Green Deal finance approach is applied since 2009 and tested in so-call Pay As You Save (PAYS) pilots, which attaches loans from an accredited 'Green Deal Provider' for low carbon building refurbishment. Repayment of the loan is then collected via a surcharge on the electricity bill and paid on to the Green Deal providers. However, the energy savings are calculated on

simplified calculated as linear addition for combined retrofit packages ignoring the coupling effects of measures combination. Besides, bill savings are calculated using prices averaged across the previous 3 years overlooked the interest rate and inflation rates. As a results, the total fundings of cost-effective measures for most properties do not exceed £10,000, which is far less the required funding for deep energy retrofit.

This paper applied a novel Energy-Flow based Ensemble Calibration model to tackle this issue, with a maximum discrepancy of 6% compared to other building performance simulation results and 0.72 s computing time on a single combination. The annualized return on investment (AROI) is investigated to evaluate the economic benefit with 9.0% AROI achieved under energy and carbon saving rate of 80% and 89%, which is higher than the inflation rate of 6.8%.

Biography:

Ke Qu is a postdoctoral research fellow worked at the University of Nottingham, UK. His main research interests focus on 1) building deep-energy retrofit and simulation; 2) holistic decarbonized electrification retrofit; 3) affordable and rapid energy retrofit technologies; 4) historic and traditional residential building retrofit; 5) energy-economic sustainable investment policy on the building energy retrofit market. Moreover, he has involved two EU horizontal 2020 project with name of REZBUILD and SUREFIT with total funding around €13 million, as well as cooperation with the international design, construction and consultancy company RIMOND for development of BIM based building retrofit cloud tools.

Efficient Nanostructured Mixed-oxide Photocatalysts for the on-board H2 Purification

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 growing interest has recently emerged on photoenergy applications of ceria, since its experimental band gap 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 0-3D nanostructured inorganic materials for energy and environmental applications.

EM is also co-founder and scientific supervisor of the Spinoff ChEERS - Circular Economy for Energetic Recycling Solutions, for a sustainable upcycling and valorization of industrial/agri-food wastes.

Fuzzy Logic and Neuro Fuzzy Logic in Electrical Parameter's Modelling of GCPV Array

KARA MOSTEFA KHELIL Cherifa* and AMROUCHE Badia

Blida 1 University, Algeria

Abstract

The enhanced precision in a photovoltaic system is an essential factor to ensure the proper functioning of the installation. For this reason, the present work employs the modelling of photovoltaic generator based on fuzzy and neuro fuzzy logic citing Takagi-Sugeno and Adaptive neuro inference system (Anfis). The developed model requires two blocks to modelled current and voltage of maximum power point respectively (Impp and Vmpp) and the inputs data for each block are climate parameters: PV cell temperature and irradiation. the validation of the proposed model has used experimental data brought from experimental plan of small grid connected PV generator (PVG).The obtained results represent remarkable results comparing to real data for both algorithms proved by three model comparison metrics RMSE, MAPE and R2 .

Biography:

My name is Cherifa KARA MOSTEFA KHELIL, I am Algerian, I am teacher at Khemis Miliana university in Algeria and researcher at Blida 1 University in SET Laboratory, I have a Phd degree, the theme of my research is Diagnosis of Photovoltaic systems. I have two publication's article in Elsevier under the title "New Intelligent Fault Diagnosis (IFD) approach for grid-connected photovoltaic systems " and " The impact of the ANN's choice on PV systems diagnosis quality" and two other publication's article, in addition to different International Conference that you can find in research gate.

Sustainable Business Strategies for District Heating

Louise Ödlund *and Danica Djuric Ilic

Linköping University, Sweden

Abstract

The European Commission has been recognized DH technology of essential importance to reach the sustainability. A flexibility in the fuel mix, and possibilities of industrial waste heat utilization, combined heat and power (CHP) production and energy recovery through waste incineration, are only some of the benefits which characterize DH technology. The aim of this study is to provide an overview of the possible business strategies which would enable for DH to have an important role towards future sustainable energy systems. The study includes a system approach where DH is seen as a part of an integrated system which consists of transport-, industrial-, and electricity sectors as well. Converting energy for running the industrial processes from fossil fuels and electricity to DH and delivering excess heat from industrial processes, would make the industry less dependent on fossil fuels and fossil fuel-based electricity, as well as increase energy

efficiency and reduce production costs. Reducing the electricity use in the industry sector while at the same time increasing the CHP production in the local DH systems would (1) replace fossil-based electricity production with electricity in biomass- or waste-fueled CHP plants, and reduce the capacity requirements from the national electricity grid (i.e. it would reduce the pressure on the bottle necks in the grid). Furthermore, by operating their central controlled heat pumps and CHP plants depending on the intermittent electricity production variation the DH companies may enable an increased share of intermittent electricity production in the national electricity grid.

Biography:

Louise Ödlund (former Trygg) is Professor in Energy System at Linköping University, Sweden. Her research area concerns regional and municipal energy systems with a special focus on district heating. By using optimization models and in close cooperation with energy utilities, industries, and real estate companies, she studies how combined energy systems of energy users and energy suppliers can shift in the direction of resource effectiveness and sustainability. Louise was engaged by the Swedish Government within the development of the Sweden´s longterm energy agreement and is a frequently engaged invited speaker for conferences and events.

Advanced Two-dimensional Materials for Electrochemical Energy Storage and Conversion

Fei Yao*, Sichen Wei, Maomao Liu, Yu Fu, and Huamin Li

University at Buffalo, Buffalo, NY

Abstract

The development of clean energy technology is indispensable in mitigating climate change and meeting future energy demand. Electrochemical energy strategies including energy storage and electrocatalysis have drawn tremendous attention lately. Two-dimensional (2D) post-graphene materials (PGMs) including transition metal dichalcogenides (TMDs) and transition metal carbides/nitrides (i.e., MXenes) have demonstrated enormous potential as electrode materials due to their large surface area, superior chemical stability, and versatile material engineering possibilities. Nevertheless, their practical application is hindered by the intrinsically low electrical conductivity arising from the semiconducting nature of 2H phase TMDs and the undesired oxidation of MXene. In this talk, I will introduce effective strategies for PGMs structure-property engineering with the aim of optimizing the electrochemical performance for the development of the next-generation Pt-group-metal-free electrocatalysts and lithium-ion battery anodes.

Biography:

Fei Yao received her dual Ph.D. degree in Energy Science from Sungkyunkwan University (SKKU), Korea, and in Physics from Ecole Polytechnique, France, in 2013. Currently, she is an assistant professor in the Department of Materials Design and Innovation at the University at Buffalo. Her research interests include low-dimensional materials synthesis, property engineering, and their applications in electrochemical energy storage and conversion, electrochromic devices, and electronic devices.

Pinpointing to Platinum Chalcogenides as Cathodic Electrocatalysts for Energy Conversions

Y. Gochi-Ponce*

National Technological Institute of Mexico/IT de Tijuana, Mexico

Abstract

Transition metal chalcogenides are materials that have been highly studied as cathodic catalysts for energy conversions, however currently there is an especial interest for those obtained by simple synthetic methodologies. One approach for fuel cells development about more cost-effective cathode and anode materials is the use of chalcogenides based in metal transition (TMCs), which also have the great advantage to enhance the electroactivity and tolerance to poisoning.

In this work, the characterization and electrochemical evaluation of platinum chalcogenides as electrocatalysts for proton exchange membrane fuel cells (PEM) are shown. The main focus here is based on the comparative analysis of a platinum commercial electrocatalyst and different platinum chalcogenide electrocatalyst at 20% metal weight supported on carbon nanostructures. The nanostructures analyzed were multiple wall carbon nanotubes (MWCNT) and they were synthetized by the modified spray pyrolysis method. Afterwards, the materials were characterized individually, with platinum and platinum modified by the following physical techniques: scanning electron microscopy (SEM) and transmission electron microscopy (TEM) to analyze the size and morphology of nanostructures; thermogravimetric analysis (TGA) to examine the variation of weight and the residue (Pt); Raman spectroscopy to study the molecular structure (crystallinity degree); and electrochemical analysis by cyclic and lineal voltamperometry to evaluate the oxygen reduction reaction.

It is worthy to mention that these electrocatalysts have been studied for microbial fuel cells; they can play an excellent role as biosensors and also achieve high specificity, lower detection limits, automation, small sample volumes and the possibility of in situ operation, among other advantages.

Biography:

Y. Gochi-Ponce is Chemical Engineer graduated from University of St. Nicholas of Hidalgo in Michoacán. MSc and Ph.D. in Materials Science from Advanced Materials Research Center, S. C., in Chihuahua, Mex. She studied electrocatalysis at Mexico-France (Universitè of Poitiers), and University of Texas at Austin. She worked at Technological Institute of Oaxaca and actually, she is a researcher at Technological Institute of Tijuana. Research focuses are on the development of novel energy materials for electrical devices from synthesis and characterization of nanoparticles and carbon nanostructures as catalysts in specific chemical reactions for energy conversion and, composite materials for different applications.

Materials Needs in Energy Engineering in the 21st Century

Wolfgang Sigmund*

University of Florida, USA

Abstract

This talk will provide an overview of some of the challenges as well as highlight advances in the development of novel energy engineering technologies and materials. About 300 years ago humans started to use fossil fuels in ever larger quantities. This plus other actions by mankind caused a human contribution of about 120 ppm of CO_2 to the atmospheric concentration. In

1897 Svante Arrhenius already estimated what impact an increase of carbonic acid in the air could have on the planet's temperatures. Today we still depend heavily on fossil fuels and experience the effects of global warming more and more. Therefore, novel directions in materials and technology development are most important, and some universities have even created "Green Energy Engineering Departments" or centers. The focus for materials is on improvements in energy harvesting, conversion, and storage. Furthermore, carbon or emission negative technologies are needed to combat the global challenge of increasing emissions.

Biography:

Wolfgang Sigmund is an ASM fellow (2013), fellow of the European Academy of Sciences (2006), 2014 fellow of the American Ceramic Society as well as a fellow of AAAS (2014). He has worked and taught globally at institutions such as Max-Planck Institutes in Germany, University of Stuttgart, RIKEN in Japan, Hanyang University in South Korea, and the University of Florida in the USA. His research focusses on processing of nanomaterials. Furthermore, he is editor-in-chief of Critical Reviews in Solid State and Materials Sciences

Emerging Dimensions of Dynamic Facades' Typologies and Technologies for Energy-Efficient Building Design and User Comfort: A State-of-the-Art Review

Ali Keyvanfarand Arezou Shafagaht*

Kennesaw State University, Marietta, GA

Abstract

A façade is one of the most complex systems in a building, coupling construction, structural engineering, environmental engineering, and architectural and aesthetic aspects. Recently, the eco-labeling facades, so-called dynamic facades, have captured the attention of building professionals. Designing the dynamic façade is the trade-off between environmental data (such as luminance and solar radiation) and user comfort and satisfaction. The lack of comprehensive studies on dynamic facades' structure has persuaded us to explore their response and adaptability to external and internal behavior changes of light and thermal intensity. In particular, this study aimed to investigate state-of-the-art dynamic facades by indicating their typologies, technologies, and techniques in energy saving, user's thermal and visual comfort, Indoor Air Quality (IAQ), and acoustic control along with a series of case studies. The study indicates that dynamic façades can be clustered into opaque, transparent, and semi-transparent types. Furthermore, the study found that, as dynamic façades vary, the building simulation tools can analyze and evaluate them from diverse aspects; mainly, i) Design (design for flexibility and modularity, aiming for full customization to specific requirements), ii) Materials (using micro and nanomaterials and processing techniques with the improved technical and functional performances), iii) Engineering system (using advanced control and monitoring systems for intelligent behavior of the building envelope), and iv) Architecture (considering the aesthetical acceptance of the building façade). Considering all mentioned aspects, double-skin facades, smart glass, integrated façades, and shading facades are the most promising dynamic façade systems that potentially reduce energy.

Biography:

Arezou Shafaghat has been a results-oriented and motivated professor, consultant, R&D project manager, and scientist for over ten years. Currently, Dr. Arezou is the Assistant professor at the College of Architecture and Construction Management, Kennesaw State University (KSU). Her interests are sustainable Urban planning, green transportation, smart infrastructure, and urban computing. Dr. Arezou is the Associate Editor at ASCE Journal of Urban Planning and Development and Frontiers in Energy Research and was the Managing Editor of the MIT Sustainable Cities Program. She received several international award-winning awards and medals for her research products: Gold medals from SIIF (Seoul International Invention Fair) 2015, Gold medals from 9th MRC (Malaysia Road Conference) 2014, Gold medals from ITEX 2015 and ITEX 2016, Gold medals and KIA, AIA, WIA Special Awards 2016 from CIGIF (Korea Cyber International Genius Inventor Fair) 2016. She has received the order of Merit for research in "Environmental design" by WIAF (World Inventor Award Fair) 2016, World Material Science Grand Award from WSA (World Scientist Awards) 2016, and iCAN 2017 Canada.

How IoT Technology Benefits Building Energy use and Occupant Wellness

Jianchuan Tan*

Pacific Northwest National Laboratory, Richland, WA

Abstract

The Internet of Things (IoT) technology is relatively new, having just gained considerable adoption in the past twenty years. As the emerging of the IoT technology, building owners and occupants have the chance to monitor their energy use and make adjustments to lower their energy demand and increase efficiency thanks to IoT technology installed in residential and commercial facilities. Building automation is based on a network of connected hardware, software, and systems that is revolutionizing built environments all over the world. Thanks to IoT technology, building occupants could also benefit from timely monitoring and adjusting indoor environment parameters, such as temperature, air quality, lighting conditions, noise level, etc.

In this presentation, the speaker will elaborate the following topics on IoT implementations and applications in building environment:

- The DOE roadmap of building energy improvements;
- A brief summary of status quo of building energy use and occupant wellness promotion;
- Typical IoT platforms and layers for applications, and the mainstream implementing schemes of IoT technology;
- Use cases of IoT technology increasing energy efficiency of buildings and help with decarbonization;
- Use cases of building occupants benefiting from IoT technology for their wellness;
- Discussion of knowledge gaps for improving the IoT applications.

Energy Savings Potential from Distributed Load in the USA: A Review of Available Technologies

Styliani I. Kampezidou* and Dimitri N. Mavris

Georgia Institute of Technology, Atlanta, GA

Abstract

To mitigate climate change concerns, renewable energy resources and energy savings in buildings have been deployed massively in the past decade in the distribution system. As far as the distributed load is concerned, several countries, including the United States, have implemented several voluntary energy savings programs for buildings and numerous technologies have been

designed to improve energy efficiency, curtail or shift energy demand and install smart equipment in buildings, such as sensors, home energy management systems, efficient lighting etc. Moreover, utilities and energy markets in the USA, have proposed incentive and price response programs for compensation of demand shaping. In this paper, an overview of potential dangers from over-investing in renewable resources is presented and a comprehensive review of the available building programs and technologies is conveyed, as an alternative method for carbon dioxide savings in the USA.

Biography:

Styliani Kampezidou is a PhD Candidate at Aerospace Design Systems Laboratory, Georgia Institute of Technology, where she also received a master's in Electrical & Computer Engineering and master's in Operations Research. Her research interests include Machine Learning, Smart Grids, Sensor Data and Optimization. She has worked and published with FAA, IARPA, US Department of Defense, US Department of Energy and CERN. She is a reviewer for Elsevier and IEEE and recipient of scholarships from Gerontelis, Leventis and State Scholarships Foundations of Greece, an honorary award from the Technical Chamber of Greece and a best paper award from IEEE NAPS 2018.

In-Silico Modeling of a Green Nanocapacitor

D. Bratko* and N. Mulpuri

Virginia Commonwealth University, Richmond, VA

Abstract:

In view of high specific area, nanocapacitors present opportunities for transient storage of electric energy with high energy and power densities and essentially unlimited recycling. As opposed to ionic liquid devices, water-based capacitors offer an additional advantage of using environmentally neutral materials. Predictions of dielectric response and capacitance in nanoscale devices cannot be made by relying to macroscopic approximations. Our molecular dynamics simulations highlight voltage-induced restructuring and associated changes in dielectric properties of a nanoconfined aqueous film in a strongly nonlinear regime. Apart from conventional dielectric saturation in the film interior, we observe a nonmonotonic permittivity dependence on the field at intermediate field strengths where the field-alignment is of comparable strength as spontaneous polarization of interfacial liquid molecules. The coupling between the two orienting effects results in significant asymmetry in dielectric responses at the opposing surfaces. In contrast to bulk dielectrics, the net permittivity passes through a maximum before transitioning to the expected saturation regime at high voltage. Analogous dielectric behavior is expected in other polar solvents with biased surface orientations

Biography:

Dusan Bratko is a Professor of Physical Chemistry at the Virginia Commonwealth University. He has previously held positions at the Department of Chemistry, University of Ljubljana, and in the College of Chemistry, University of California at Berkeley. His research concerns statistical mechanics and molecular modeling of ionic solutions, colloids and interfacial liquids of interest in nanoscience, energy, and materials engineering.

Industrial Convergence to Achieve Carbon Neutrality in the Agricultural Sector-economic Benefits of the Agrivoltaics System

Seiichi Ogata* and Hideki Nakata

Kyoto University, Japan

Abstract

There are high expectations for "industrial convergence" towards carbon neutrality, and this study presents an economic analysis of such industrial convergence and a new socio-economic system. The driving force for this industrial convergence is the use of renewable energy. For example, the shift to electric vehicles, the expansion of clean energy infrastructure as seen in clean hydrogen/ammonia, and the electrification of industry. In addition, new battery business models and energy aggregation businesses are emerging from the convergence with the information industry, such as smart cities and the Internet of Energy. This study reports on the integration of the agricultural sector with the renewable energy industry as a new possibility of industrial integration towards the realization of such carbon neutrality in japan. This will accelerate industrial convergence, such as the electrification of agricultural machinery and spillover to smart agriculture integrated with the telecommunications industry, and the carbon reduction and regional economic benefits of this are not small. It also has potential for industrial integration with the bio-industry, for example. The economic impact of such Agrivoltaic systems in japan case and the results of a scenario analysis for the realization of carbon neutrality are presented.

Biography:

Associate Professor, Graduate School of Energy Sciences, Kyoto University. Specializes in energy economics and policy. He holds a Ph.D. in policy science. He conducts cost analysis of renewable energy and economic analysis of socio-economic systems for achieving carbon neutrality.

Barriers that Hinder the Adoption of Building Energy-efficient Technologies in Brazil

Talita Mariane Cristino*, Antonio Faria Neto and Otávio José de Oliveira

São Paulo State University (UNESP), Brazil

Abstract

Energy is one of the most important factors for the growth of the world economy, thus its demand has increased over the years. Such a growing brings, among several issues, environmental impacts, mainly the increase of greenhouse gas emissions. In Brazil, the building sector is responsible for 51% of the electricity consumed, and about 10% of the total greenhouse gas emissions. These numbers continue to grow, despite significant efforts made to promote the adoption of building energy efficiency technologies, which have not been widely adopted due to barriers. Thus, before overcoming such barriers, it is necessary to know them. A systematic literature review revealed 27 barriers, classified into six categories, as being responsible for hindering the adoption of energy-efficient technologies. This article aims to verify whether such barriers make sense in the Brazilian context. In order to accomplish this goal, a survey among one thousand Brazilian professionals was carried out. The results are analyzed by two multivariate techniques, cluster and factor analysis, validating these obstacles as well as the proposed taxonomy for Brazil. The results also show that the two most important categories of obstacles are Governmental/Political/Regulatory, and Financial/Economic, showing that Brazilian society has high expectations that the government will be more active in this matter. Furthermore, the survey respondents gave insights into important points concerning technology, education, etc. that should be verified in a timely manner. These findings

can assist government agencies, researchers, and experts to develop guidelines and strategies to overcome such barriers.

Biography:

Talita Mariane Cristino is a doctoral student in Mechanical Engineering, in the area of Management and Optimization, at the State University of São Paulo "Júlio de Mesquita Filho" (UNESP), under the guidance of Professors Dr. Otavio Jose de Oliveira and Dr. Antonio Faria Neto. The research carried out by Talita Mariane Cristino has received financial support from the Sao Paulo State Research Support Foundation, process n° 2021/01423-9. The student has research experience in the Energy Management System area, mainly in the Building Sector, applying multivariate statistical methods for data analysis, and has published scientific articles in international high-impact factor journals.

Integration of biomass power plant with thermochemical energy storage system using a fluidized bed for flexible power generation

Chihiro Fushimi*, Takayuki Uchino, Takahito Yasui and Masahiro Aoki

Tokyo University of Agriculture and Technology, Japan

Abstract

We integrated a biomass power plant with thermochemical heat storage (TCS) system using a fluidized bed reactor as one of the Carnot battery systems to supply flexible power with low cost. In charging time, the surplus electricity was converted into heat and stored by dehydration reaction of $CaO/Ca(OH)_2$ particles. In discharging time, the heat from hydration reaction was converted to electricity through the turbine of the biomass power plant to supply of the electricity. Steam was used as a fluidizing gas and reaction gas. Dynamic simulation was conducted on the fluidized bed model by using Excel VBA. We also integrated this dynamic fluidized bed model with organic Rankine cycle (ORC) and steam Rankine cycle (SRC) of the biomass power plant by using Aspen Plus. The energy efficiencies and the flexibility of the power generation and the levelized cost of storage (LCOS) were evaluated. Results show the energy storage efficiency and overall energy efficiency were 58.5% and 9.79% in the case of ORC, respectively. The energy storage efficiency increased by increasing the heat recovery from steam after a reactor and this can decrease the biomass combustion (fuel consumption) in charging time. It was found the increase of the turbine output and discharging time were flexibly changed in discharging time by changing operational parameters. The LCOS can be reduced to approximately 0.2 USD/kWh_e when the cost of charging electricity is zero or negative values. It is very feasible to add flexibility to biomass power plants by integrating TCS with relatively low price.

Biography:

Chihiro Fushimi is Professor of Department of Chemical Engineering at Tokyo University of Agriculture and Technology (TUAT) since December 2020. He received B.S. M.S. and Ph.D. in Chemical Engineering from The University of Tokyo in 1999, 2001 and 2004, respectively. He worked at University of Hawaii, RITE (Japan) and The University of Tokyo before joining TUAT as Associate Professor in October 2011. He was Visiting Professor at Curtin University in 2019. His research topics are thermochemical conversion of carbonaceous materials, fluidized bed technologies, power generation, biomass conversion technologies, and process design and development. He has 81 peer-reviewed journal publications.

Fabrication of a Stable CdS Photoanode for CO_2 Reduction by Combination of Biocatalyst under Visible-light Irradiation

Masanobu Higashi*, Takumi Toyodome, Itsuki Tanaka, Tomoko Yoshida and Yutaka Amao

Osaka Metropolitan University, Japan

Abstract

Photocatalytic and photoelectrochemical (PEC) CO_2 reductions using semiconductor materials under solar light have attracted significant attention. Most metal sulfides, such as CdS, have suitable conduction band levels for CO_2 reduction and narrow bandgaps, enabling visible-light absorption. However, most metal sulfides are unstable in aqueous solution under photoirradiation due to the occurrence of self-oxidative deactivation (photocorrosion) by photogenerated holes (e.g., CdS + $2h^+ \rightarrow Cd^{2+}$ + S). CO_2 reduction in an aqueous solution competes with H_2 evolution because the CO_2 reduction potential is more negative compared to the water reduction potential. Therefore, the catalysts that can selectively reduce CO_2 have been utilized to suppress water reduction. Enzymes are biocatalysts that only act on specific substrates. For example, formate dehydrogenase (FDH) can reduce CO_2 to formate with 100% selectivity by accepting electrons from coenzyme NADH or an artificial coenzyme such as methylviologen (MV). We have recently reported PEC reduction of CO_2 to formate using a sacrificial reagent-free system consisting of a TiO_2 photoanode and FDH.[1] However, this system cannot utilize visible light owing to the wide bandgap of TiO_2 (photoabsorption edge: approximately 400 nm). In this study, we attempted to fabricate stable CdS photoanode and construct a hybrid system consisting of the CdS photoanode, NADH, and FDH from *Candida boidinii* (CbFDH) for the reduction of CO_2 to formate under visible-light irradiation.

1. T. Ishibashi, M. Higashi, S. Ikeda, Y. Amao, *ChemCatChem*, 2019, **11**, 6227.

Photocatalytic Water Splitting for Solar Hydrogen Production

Kazunari Domen*

University of Tokyo, Japan

Abstract

Photocatalytic water splitting driven by sunlight has been attracting growing interest as a means of producing renewable solar hydrogen on a large scale. It is essential to improve the solar-to-hydrogen energy conversion efficiency (STH) of particulate photocatalysts and develop reaction systems radically. In my talk, recent advances in the development of photocatalytic materials and reaction systems will be presented.

The author's group has studied various semiconducting oxides, (oxy)nitrides, and (oxy) chalcogenides as photocatalysts for water splitting. Recently, the apparent quantum yield of $SrTiO_3$ in photocatalytic overall water splitting has been improved to more than 90% at 365 nm, equivalent to an internal quantum efficiency of almost unity. The author's group has also been developing panel reactors for large-scale applications. A solar hydrogen production system based on 100-m^2 arrayed photocatalytic water splitting panels equipped with an oxyhydrogen gas-separation module was built, and its performance and system characteristics including safety issues were reported recently.

For practical solar energy harvesting, it is essential to develop photocatalysts that are active under visible light irradiation. Ta_3N_5 and $Y_2Ti_2O_5S_2$ photocatalysts are active in overall water splitting via one-step excitation under visible light irradiation. Particulate photocatalyst sheets consisting of

La- and Rh-codoped $SrTiO_3$ and Mo-doped $BiVO_4$ efficiently split water into hydrogen and oxygen via two-step excitation, referred to as Z-scheme, with a STH exceeding 1.0%. Some other (oxy) chalcogenides and (oxy)nitrides with long absorption edge wavelengths are also applicable to Z-scheme photocatalyst sheets and hold the promise of realizing greater STH values.

Biography:

Kazunari Domen received B.S. (1976), M.S. (1979), and Ph.D. (1982) honors in chemistry from the University of Tokyo. Dr. Domen joined Chemical Resources Laboratory, Tokyo Institute of Technology in 1982 as Assistant Professor and was subsequently promoted to Associate Professor in 1990 and Professor in 1996. Moving to the University of Tokyo as Professor in 2004, and Cross appointment with Shinshu University as Special Contract Professor in 2017. University Professor of the University of Tokyo in 2019. His research interests include heterogeneous catalysis and materials chemistry, with particular focus on surface chemical reaction dynamics, photocatalysis, and solid acid catalysis.

The Application of Single Atom Catalysts for Advanced Na-S/Se Batteries

Fengping Xiao*and Peng Hu

Yunnan Normal University, China

Abstract

The emerging room-temperature sodium-sulfur (RT Na-S) and sodium-selenium (Na-Se) batteries are considered as promising alternatives for Li-ion batteries, owing to their high theoretical energy densities and natural abundance of sodium sources. However, these sodium- based batteries still suffer from poor conductivity of sulfur and selenium, a large volume expansion during cycling, and more importantly, the formation of soluble sodium polysulfides/polyselenides (Na_2S/Se_n, n = 4–8) in the liquid electrolyte (shuttle effect), which have seriously impeded their practical application.

To enhance the electrochemical kinetics between S/Se and Na^+, two kinds of single atom catalysts decorated cathodes have been developed from metal-organic framework (MOFs) precursors, which exhibited superior cycle stability and excellent rate performance. Firstly, a N,O-doped carbon matrix with Cu single atoms was derived from a bimetallic Cu-Zn MOF, solid-state nuclear magnetic resonance, synchrotron X-ray absorption spectroscopy and single-crystal X-ray diffraction analysis show that single atoms of Cu are coordinated with two N and two O atom within the produced carbon-based composite material. Interestingly, besides facilitating the conversion between polysulfides and Na_2S, those copper sites can also weaken S-S bonds in the S_8 ring structure, and thus are able to catalyze the formation of short-chain sulfur molecules in even larger-size pores. Secondly, starting from the Ni&Zn-MOF, a N,O-codoped porous carbon host decorated with Ni single-atom catalyst was derived for Se storage. This composite accelerated the reaction kinetics of Se and Na^+, and at the same time, weakened the Se-Se bond owing to its high adsorption to the Se_8 ring.

Biography:

Fengping Xiao received her Ph.D. degree from City University of Hong Kong, Hong Kong, in 2021 and is now an assistant professor in the College of Chemistry and Chemical Engineering at Yunnan Normal University. Her research interests are mainly focused on the design and synthesis of novel nanostructured materials and their applications in sodium-ion batteries and room temperature sodium-sulfur/selenium batteries.

Degradation Mechanism of Garnet-based All-Solid-State Li Batteries Studied by Electrochemical Impedance Spectroscopy

Eric Jianfeng Cheng*, Yosuke Kushida, Takeshi Abe and Kiyoshi Kanamura

Tokyo Metropolitan University, Japan.

Abstract:

Solid-state Li batteries have the potential to achieve both high safety and high energy densities. Among various solid-state electrolytes, the garnet $Li_7La_3Zr_2O_{12}$ (LLZO) is one of the few stable against Li metal. However, the large interfacial resistance between LLZO and cathode materials severely limits the practical application of LLZO. Introducing a buffer layer is a feasible way to reduce the large interfacial resistance. Here a Li_3BO_3 (LBO)-coated $LiCoO_2$ (LCO) composite cathode layer was deposited onto an Al-doped LLZO substrate at room temperature by aerosol deposition. The LBO functioned as a self-formed buffer layer and joined the LCO particles to the LLZO substrate at heating, leading to a substantial decrease in the interfacial resistance between LLZO and LCO. All-solid-state Li/LLZO/LBO-LCO cells could deliver an initial discharge capacity of 128 mAh g^{-1} at 0.2 C and 60 °C and demonstrated relatively high capacity retention of 87% after 30 cycles, representing one of the best results of garnet-based all-solid-state Li cells. The cell degradation mechanism was studied by electrochemical impedance spectroscopy (EIS), and the increase of the interfacial resistance between LBO and LCO was found to be the main reason. In-situ SEM analysis verified the hypothesis that the rise of the interfacial resistance was mainly caused by interfacial cracking and contact loss between LBO and LCO upon cycling. This study demonstrated the capability of EIS as a powerful non-destructive in-situ technique to investigate the failure mechanism of all-solid-state batteries.

Biography:

Eric Jianfeng Cheng is a Research Assistant Professor at Tokyo Metropolitan University. He obtained a PhD in Materials Engineering from Tohoku University and another PhD in Materials Energy Chemistry from Kyoto University. He once worked as a Research Associate at the University of Michigan and the University of Yamanashi. His research interests focus on ceramic solid electrolytes, Li metal batteries and structural ceramics.

Hypothetically Replacing a Major Nuclear Power Plant in NC with Small Modular Nuclear Reactors

David N. McNelis*

UNC, Chapel Hill, NC

Abstract:

Two teams of Senior Environmental Science or Environmental Studies students at the University of North Carolina at Chapel Hill, during a Capstone class, accepted the task of hypothetically replacing a major Nuclear Power Plant in NC with Small Modular Nuclear Reactors (SMR)s. The group of SMRs selected must closely match the power level of the major NPP; fit within the same footprint and be deployable by 2035. The SMRs chosen, either a light water reactor, a fast reactor, a molten salt reactor or a high temperature gas-cooled reactor, must also be designed to be placed underground and be walk-away-safe.

Finally, the SMRs would be fabricated and assembled in a factory and trucked or barged to the site of the major NPP for emplacement. These SMRs are advanced reactors and will be more resilient than the online systems in use today.

They are responsive to the concerns of the public with respect to safety, nuclear waste, proliferation and cost. There are no off-site consequences, and they will provide a major contribution in addressing climate change.

One team selected the Harris plant for their research and ultimately incorporated NuScale's light water SMRs while the other team selected Brunswick 1 reactor and used X-Energy's high temperature gas-cooled reactor with TRISO fuel. The rationale for the decisions made and the technology incorporated will be presented.

Magnetized CaO-zeolite Heterogeneous Catalyst Derived from Chicken Eggshell and Rice Husk for Biodiesel Production from used Cooking Oil

Norzita Ngadi* **and Nurul Saadiah Lani**

Universiti Teknologi Malaysia, Malaysia

Abstract

A novel magnetic supported CaO-zeolite/Fe_3O_4 catalyst was developed and applied for biodiesel production from transesterification of used cooking oil (UCO). With the aim of environmental sustainability, this study provided an innovative route for waste-derived catalyst synthesis by utilizing waste chicken eggshell and rice husk as a raw materials. Response Surface Methodology (RSM) based Central Composite Design (CCD) was performed to investigate the effect of reaction parameters and optimize biodiesel yield. Meanwhile, the pseudo-zero, pseudo-first and pseudo-second order models were evaluated to describe their kinetics. As a result, the catalyst characterizations confirmed the successful production of CaO-zeolite/Fe_3O_4 with large surface area (135.312 m^2/g), high porosity (11.921 nm) and strong saturation magnetization value (31.759 emu/g), which further offer superior transesterification performance and easy catalyst separation from reaction mixture using an external magnet. The optimized biodiesel yield of 92.00% was obtained under reaction conditions of 3.29 wt% catalyst loading, 5.66:1 methanol to oil molar ratio, 221.78 minutes reaction time and 57.69 °C reaction temperature, where the reaction temperature was identified as the most dominant factor in predicting the model. In conclusion, the CaO-zeolite/Fe_3O_4 catalyst produced from waste materials in this study was proven to have significant potential for a viable and large-scale biodiesel production.

Economic Growth: The Nexus of Oil Price Volatility and Renewable Energy Resources Among Selected Developed and Developing Economies

Muhammad Siddique

National College of Business Administration & Economics, Pakistan

Abstract

This paper explores how nations might mitigate the unfavorable impacts of oil price volatility on economic growth by switching to renewable energy sources. The impacts of uncertain factor price on economic activity are examined by looking at the Realized Volatility (RV) of oil prices rather than the more traditional method of looking at oil price shocks. The United States of America (Ӝ), China (Ç), India (Ґ), United Kingdom (Ҡ), Germany (Ҕ), Malaysia (Ӎ), and Pakistan (Ԓ) are all included to round out the traditional literature's examination of selected nations, which focuses on oil-importing and exporting economies. Granger Causality Tests (GCT), Impulse Response Functions (IRF), and Variance Decompositions (VD) demonstrate that in a Vector Auto-Regressive (VAR) scenario, the

negative impacts of oil price volatility extend beyond what can be explained by oil price shocks alone for all of the nations in the sample. Different nations have different levels of vulnerability to changes in oil prices, and other factors that may play a role in a sectoral composition and the energy mix. The conventional method, which only takes into account whether a country is a net oil importer or exporter, is inadequate. The potential economic advantages of initiatives to decouple the macroeconomy from volatile commodities markets are shown through simulations of volatility shocks in alternative energy mixes (with greater proportions of renewables). It is determined that, in developing country like Pakistan (Д), increasing the use of renewable energy sources might lessen an economy's sensitivity to changes in oil prices; nonetheless, a country-specific study is required to identify particular policy actions. In sum, the research provides an innovative justification for mitigating economic growth's dependence on stable oil prices in our sample countries.

Smart Nutrient Delivery for Climate Smart Crop, Finger Millet can Enhance Biomass Production and Bioenergetics

Biswajit Pramanick*, Sanju Chaudhary, Mukesh Kumar and Santosh Kumar Singh

Dr Rajendra Prasad Central Agricultural University, India

Abstract

Finger millet, nutri-cereal and a certain crop under uncertain climate, is cultivated as a marginal crop without adopting proper management leading to its low productivity as well as energy budgeting in calcareous soils. Smart nutrient delivery using site-specific nutrient management (SSNM) considering the nutrient supply from soil can ensure optimum production, better nutrient as well as energy use-efficiency of this crop. Considering this, a field experiment was conducted during rainy seasons of 2020 and 2021 in calcareous soil at RPCAU, Pusa, India. The experiment consisted of 8 treatments viz. control, N/P/K-omission, 75%, 100%, 125% recommended dose of fertilizer (RDF), and 100% recommended P and K + 30 kg ha^{-1} N as basal + rest N as per GreenSeeker reading. From this study, it was observed that the GreenSeeker-based SSNM resulted in the maximum grain yield (2873 kg ha^{-1}), agronomic efficiency (16.1 kg kg^{-1}), partial nutrient budget (1.17 kg kg^{-1}) and net output energy (96.3 GJ ha^{-1}) of finger millet. Application of 125% RDF showed at par result with GreenSeeker-based nutrient management concerning yield and nutrient-uptake. However, nutrient and energy use-efficiency were found much lower under 125% RDF. Thus, it can be recommended that 100% recommended P and K + 30 kg ha^{-1} N as basal + rest N as per GreenSeeker reading can improve yield, nutrient use-efficiency and energy balance of finger millet in calcareous soils.

Key word: Energy; Finger millet; GreenSeeker; Site-specific nutrient management; Yield

Biography:

Biswajit Pramanick, PhD has been working as an Assistant Professor, Agronomy in Dr RPCAU, Pusa since 2019. Before that he was in the same post in the harbinger of green revolution, India, the GB Pant University of Agriculture & Technology, Pantnagar. Dr. Pramanick is a cropping systems agronomist. His research interest is to develop climate-smart sustainable energy vis-à-vis nutrient use-efficient cropping systems. So far, Dr. Pramanick has published 46 research papers in peer reviewed international journals with cumulative impact factor of 104.213. He has got h-index of 15 with 495 citations in scientific literatures.

Bharat Hi-star: High Performance Domestic LPG Cooking Stove with Improved Thermal Efficiency

Aniruddha Kulkarni*, Rahul Garg, Satish Dayal Yadav, Renny A. M. and Ravi Kumar V.

Bharat Petroleum Corporation Ltd, India

Abstract

The present paper describes an energy efficient domestic Liquefied Petroleum Gas (LPG) cooking stove that facilitates combustion of LPG fuel at high thermal efficiency. With increasing demand, there is a need to lay emphasis on judicious and optimal usage of LPG. Need was envisaged to analyze the present status of combustion and heat transfer in domestic cook-stoves and explore ways to maximize thermal efficiency. BPCL (Corporate R&D Centre) has undertaken this project to develop domestic LPG cooking stove with improved thermal efficiency through software assisted modeling simulation and laboratory experimental methods. Detailed experimental work was conducted to infer the influence of following components on thermal efficiency: • Burner top – flame orientation • Mixing tube – Primary air entrainment and mixing • Loading height – pan support design • Cover plate (drip tray) Design of experiments (DOE) based Computational Fluid Dynamics (CFD) Analysis of LPG Domestic Cooking Stove Gas with carried out. Multiple prototypes of various components were fabricated based on extensive CFD simulation studies. Based on experimental validation and analysis, final design was firmed up. Test results indicated 74% plus thermal efficiency of the optimized domestic cook-stove, which is 5-6% higher than the presently available cook-stoves in the market. If Bharat Hi-Star is made available at all households of India, it will result in saving of 1.7 MMT of LPG consumption annually, which will translate into savings of INR 7,000 Crore per annum for the country. This is equivalent of savings of 5.4 MMT CO_2 emission reduction. This is the biggest benefit to the environment.

Biography:

Aniruddha Kulkarni is working as a Manager (R&D) at Corporate Research and Development Centre of Bharat Petroleum Corporation Limited. He has completed his M. Tech in Mechanical Engineering from Indian Institute of Technology (IIT) Madras, Chennai with specialization in thermal engineering. His areas of research include combustion, heat transfer, optimization of mechanical equipment, Computational Fluid Dynamics (CFD), Finite element analysis (FEA), Low grade energy utilization. He has got the award in Frost and Sullivan – PERP 2020 in the Environmental leadership categories. He won the first position in "Urjaalekh 2022" under the category of 'HSE & QUALITY.

K Model: A Web-based Software for Predicting Crude Oil Blend Compatibility and Blend Optimization for Increasing Heavy Crude Oil Processing

Rajeev Kumar*, Ravi Kumar Voolapalli, Pranab Kumar Rakshit and Aniruddha Kulkarni

Bharat Petroleum Corporation Ltd., India

Abstract

In a refinery operation, the profitability margin is increased when heavy crude fractions are blended with light crude without affecting its processability. High asphaltene content in heavy oils can affect the Desalter operation by strong water emulsions with asphaltene, fouling in heat exchangers means excess fuel firing and emissions, and/or coking issues during processing. If this happens, refineries can lose more than the advantage of purchasing the heavy crudes. Thus the accurate prediction of crude compatibility can be a robust tool which refinery operators would like to use before starting any process. Current benchmark processes to determine compatibility

of crude oils is done experimentally and takes minimum weeks' time to complete. The limitation of existing lab tests is only two crude oils blend compatibility can be done at a time. To check three crude oils or more, compatibility of first two to be done and then mix of the two with the third and subsequent ones is time consuming and exhaustive. In the present work, a quick and accurate method for crude oil blend compatibility (K Model) is developed by coefficients obtained by regression analysis between the ratios of physical parameters of known crude oils and composite compatibility measure determined from multiple compatibility test results of the known crude oils. These compatibility tests are viz. colloidal instability index (CII), colloidal stability index (CSI), Stankiewicz plot (SP), qualitative-quantitative analysis (QQA), stability cross plot (SCP), Heithaus parameter (or parameter P), Heptane Dilution (HD), toluene equivalence (TE), spot test, oil compatibility model (OCM). K model requires few physical parameters of crude oils as input for optimization. The physical parameters of the crude oil include at least Sulphur, Carbon Residue, API and Kinematic Viscosity. The parameters included for blend optimization are viz. (a) compatibility, (b) viscosity, (c) pour, (d) acidity, (e) nitrogen, (f) total distillates, along with feedstock constraints. Based on the innovation, a web based software is developed which runs over internet and predicts results rapidly (https://www.bpcl.kmodel.in). This enables to arrive at an optimum blend based on economics, availability and processing feasibility on real time basis, thereby promoting simultaneous evaluation of multiple crude mix options in quick time and take more informed decisions. This also facilitates feeding compatible and healthy diet to refinery to maintain equipment health, smooth operation, energy saving and reduce carbon footprint. This way, "K Model: Blending for future" adds a new dimension to the entire oil sourcing process.

Scenario Analysis of Generation Dispatch with EV Penetration – A Renewable Energy Dominated Electricity System Perspective

Malolan Sundararaman* and Balasubramanian Sambasivam

National Institute of Technology Tiruchirappalli, India

Abstract

In recent years, with the increasing number of Electric Vehicles (EVs), electricity demand for EV charging has increased. Additionally, renewable energy transition has been at the forefront of the electricity sector. Primary renewable energy technologies like solar and wind power have inherent variability attached to them during generation. In this scenario, matching the electricity supply and demand is challenging and effective dispatch of available supply resources is essential. In this study, we have proposed a Mixed Integer Linear Program (MILP) model to simulate effective supply-demand matching to maximize the use of available renewable energy sources using the case study of a renewable energy-dominated real-time electricity system. The model considers actual electricity demand, location-specific capacity factors of solar power, wind energy, and plant-specific data of conventional power plants. The model tries to meet demand with the lowest and highest capacity factors for the supply resources (worst-case and best-case scenario analysis). This is done to explore the resource constraints of the renewable energy-dominated electricity system, which helps in appropriate capacity planning. The results from the study show that with high resource constraints, the model can meet only a portion of the demand with cost benefits but with more emissions. Future studies can explore the emission reduction potential by waiving the resource constraints. The significant contribution of the study includes matching the electricity supply and demand in a real-time renewable energy-dominated electricity system by constraining the availability of supply-side resources and providing optimal dispatch strategies for the effective operation of future electricity systems.

Biography:

Malolan Sundararaman is an Assistant Professor in the Department of Management Studies at the National Institute of Technology Tiruchirappalli, India. He is highly passionate about topics in the area of Operations Management, Applied Data Analytics, Industry 4.0 and Sustainable Environment Policies. Therefore, his research primarily focuses on the application of data for solving business problems, resulting in both resource savings and economic benefits.

Design of a solar PV array to achieve net zero energy for a building in Las Vegas, Nevada: A modeled residential building with higher energy efficiency comparison case.

Bishal Poudel

University of Nevada, Las Vegas, Las Vegas, NV

Abstract

Residential buildings are one of the major energy consumers in the USA and are responsible for large carbon emissions. The energy efficiency of a building should be determined using predictive models and weather conditions. The energy performance of a building can be analyzed using various energy modeling software. This study uses the eQUEST software to run the energy simulation of a generic building as per the Las Vegas climate and conditions. The analysis considers two models, the base model, and the energy efficiency model. All the parameters are kept constant except the efficiency of heating, ventilation, and air conditioning (HVAC), Domestic Hot Water (DHW), and size of Solar Photovoltaics. The analysis compares the life cycle cost and energy results of building models with an economic profitability perspective. The difference between these models provides the net life-cycle cost and total energy savings. Sensitivity analysis shows low to moderate sensitivity of input assumptions. This paper concludes that efficiency investments offer substantial energy and cost savings over the project life cycle by reducing the required Photovoltaic system size.

Biography:

Bishal is a civil engineer from Nepal. Currently, he is pursuing a master's degree in civil engineering concentration in construction at the University of Nevada, Las Vegas, USA. He is interested in sustainable construction. He is a self-motivated person who believes in integrity, and honesty. He has about 4 years of work experience in construction in Nepal, and currently, he is working in a construction company in the USA.

We wish to see you In-Person at

GEM-2024

Los Angeles, CA

USG-UNITED SCIENTIFIC GROUP
(A non-profit organization)

8105, Rasor Blvd - Suite #112, PLANO, TX 75024, USA
Ph: +1-469-854-2280/81 | **Email:** energy@uniscigroup.net
Web: www.energy-conferences.com