ICREN 2018

INTERNATIONAL CONFERENCE ON RENEWABLE ENERGY

APRIL 25-27, 2018 | BARCELONA

BOOK OF ABSTRACTS

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ISSN 2609-374X

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2- and 3-Dimensional Materials for Electrochemical Capacitors

Wednesday, 25th April - 09:05 - Plenary Speeches - Auditorium - Oral - Abstract ID: 442

Prof. Patrice Simon [1]

1. *Université Paul Sabatier, CIRIMAT UMR CNRS 5085, F-31062 Toulouse*

In the past decade, lot of attention has been put on electrochemical double layer capacitors (EDLCs), also known as supercapacitors, since they are one of the most promising electrochemical energy storage devices for high power delivery or energy harvesting applications.
During this presentation, we will show how the careful design of the material/electrolyte interface can help in designing high energy density carbons for supercapacitor applications. The first part of the talk will be dedicated to the study of the ionic fluxes and ion adsorption into porous carbon materials. The combination of several techniques like in-situ NMR spectroscopy, EQCM and simulations has then been used for studying the ion confinement effect in carbon nanopores and helped in developing our basic understanding of the electrolyte/carbon interactions in confined pores. A last part of the presentation will be presented some perspectives beyond the carbon-based supercapacitors offered by2-Dimensional MXene materials, for increasing the energy density of these devices.

Solving Materials Challenges for Proton Exchange Membrane Fuel Cells

Wednesday, 25th April - 09:40 - Plenary Speeches - Auditorium - Oral - Abstract ID: 397

Dr. Deborah Jones [1]

1. *CNRS - ICGM - University of Montpellier*

Proton exchange membrane fuel cells require disruptive solutions in materials in order to address the remaining challenges in increasing performance and durability while also reducing costs. Only then will the expectations for broad market introduction be met. These challenges include very thin polymer membranes with exceptional chemical and mechanical stability and low electrical resistance, reducing or even totally replacing platinum group metals at the fuel cell electrodes, without compromising activity or stability, and corrosion-resistant, highly conducting catalyst supports. Moreover, increasing the power density of membrane electrode assemblies requires optimisation of all interfaces to reduce resistive contributions.
We will describe some original approaches to proton exchange membrane fuel cell materials including new architectures for fuel cell electrodes, membranes and their reinforcement and chemical stabilisation components, and their integration in membrane electrode assemblies for next generation fuel cells.

Mitigation of Fuel Cell PFSA Membrane Chemical Degradation using Composite Cerium Oxide-PFSA Nanofibres, M. Zaton, J. Rozière, D. J. Jones, *J. Mater. Chem. A*, (2017), 5, 5390 – 5401.
Current Understanding of Chemical Degradation Mechanisms of Perfluorosulfonic Acid Membranes and their Mitigation Strategies: A Review, M. Zaton, J. Rozière, D. J. Jones, *Sustainable Energy & Fuels*, (2017) 1, 409-438

Design of Heterogeneities and Interfaces with Nanofibers in Fuel Cell Membranes, M. Zaton, S. Cavaliere, D. J. Jones, J. Rozière, in: *Handbook of Nanofibers,*A. Barhoum et al. (eds.), Springer International Publishing AG 2018, https://doi.org/10.1007/978-3-319-42789-8_32-1
Towards Ultrathin Pt Films on Nanofibres by Surface-Limited Electrodeposition for Electrocatalytic Applications, G. Ercolano, F. Farina, S. Cavaliere D. J. Jones, J. Rozière, *J. Mater.Chem. A*, (2017), **5**, 3974-3980.
Toward PGM-free Catalysts for H_2/air Proton-Exchange Membrane Fuel Cells, F. Jaouen, D. Jones, N. Coutard, V. Artero, P. Strasser, A. Kucernak, *Johnson Matthey Technical Review* (2018) 62.

New 2D Materials for Storage and Harvesting of Electrical Energy

Wednesday, 25th April - 10:45 - Plenary Speeches - Auditorium - Oral - Abstract ID: 451

Prof. Yury Gogotsi [1]

1. *Drexel University*

TBD

Energy and environment friendly materials research for sustainable chemical energy storage

Wednesday, 25th April - 11:25 - Plenary Speeches - Auditorium - Oral - Abstract ID: 173

Prof. Joan Ramón Morante [1]

1. *Catalonia Institute for Energy Research (IREC)*

In the energy transition road map, the foreseen introduction of renewal energy sources together the use of smart grids arises very relevant questions concerning the availability of energy storage systems. In this framework, spite of the huge efforts performed in the electrochemical battery developments, the capacity for storing very large quantities of energies is still an open challenge especially considering the limitations shown by the current technologies for higher energies than some MWh's.

In this talk, chemical energy storage will be presented as a clear alternative for contributing to storage very large quantities of energy in the range of GWh. Direct and indirect use of the solar energy will be reviewed. Special attention will be paid in the production of solar fuels (Hydrogen and CO2 reduced products) as well as in the potential uses of the solar hydrogen or the green electricity for producing fuels such as the synthetic ones, the green methane or added value chemical's.

Likewise, catalyst material developments and electrochemical cell configurations will be discussed and, finally, the efficiency values will be connected with the different involved mechanisms in transforming solar or electrical energy in chemical one.

Biomass derived carbon electrodes with reduced graphene oxide for ultrahigh performance supercapacitor

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 389

Dr. Ji-Hyuk Choi [1]***, Mr. Chongmin Lee*** [2]***, Dr. Byung-su Kim*** [1]***, Dr. Hee Dong Jang*** [1]

1. *Korea Institute of Geoscience and Mineral Resources,* ***2.*** *Korea University of Science and Technology*

In order to meet the growing energy demands of modern society while simultaneously reducing global warming, the development of advanced energy generation and storage systems that are sustainable and have high efficiency should be a priority. Supercapacitors, due to their excellent power density and long cycle life, have been considered an attractive energy storage system for emerging technologies like wearable electronic devices and hybrid electric vehicles. Among potential electrode materials for supercapacitors, activated carbons derived from renewable bio-waste appear to be a promising candidate due to their low cost and environmentally-friendly nature, as well as unique surface properties, which result from function groups containing heteroatoms. However, their use in energy storage is still limited by their low energy density, which is a formidable barrier for industrially extensive applications. Therefore, beyond the development of the active material itself, the rational design of electrodes regarding various components and their interaction and structure is recognized as crucial for the further progress of supercapacitors. In the present work, a novel electrode composed of activated carbons prepared from waste coffee grounds and single and few layered sheets of reduced graphene oxide intervening between the activated carbon particles enables the fabrication of ultrahigh performance supercapacitors. They present significantly enhanced capacitance in both aqueous and non-aqueous electrolytes, with good rate performance and cycling life stability, compared to previous devices.

Bioenergy for water desalination using advanced carbon materials as anode and cathode electrodes

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 392

***Mr. Pau Bosch-Jimenez* [1], Dr. Daniele Molognoni [1], Mr. Martí Aliaguilla [1], Dr. Clara Corbella [1], Ms. Victoria Miles [1], Ms. Patricia Zamora [2], Mr. Juan Arevalo [2], Mr. Jose M. Viñas [2], Dr. Víctor Monsalvo [2], Dr. Frank Rogalla [2], Dr. Ruediger Schweiss [3], Dr. Almut Schwenke [3], Dr. Eduard Borràs [1]**

1. *LEITAT Technological Center,* ***2.*** *Aqualia, Innovation and Technology Department,* ***3.*** *SGL Carbon GmbH*

Current desalination technologies require high energy input, being reverse osmosis (RO) the most-widely used technology for seawater desalination with an energy consumption of at least 3 kWh/m^3. In this context, MIDES project aims to revolutionize desalination by developing a low-energy sustainable process called Microbial Desalination Cell (MDC) as a pretreatment for RO. The integration of MDC technology with commercial RO allows seawater desalination with an energy consumption below 0.5 kWh/m^3. MDC treat simultaneously wastewater and perform desalination using the energy contained in the wastewater. In fact, MDC can produce around 1.8 kWh of bioelectricity from energy contained in 1 m^3 of wastewater. This energy is directly used to lower salt content in seawater from 35 to 5 g/L (brackish water) without external energy input. The performance of anode and cathode electrode is a parameter that must be optimized using advanced materials to obtain a high desalination rate. Here, the properties, the developments and the characterizations of anode and cathode electrodes based on carbon materials are presented.

Carbon materials are perfect material to use as anode material because are nontoxic and biocompatible with microorganisms, have resistance to corrosion, good electrical conductivity, adjustable surface morphology and chemistry and economic fabrication. The performance of more than 20 carbon materials was evaluated as anode electrode by monitoring the inoculation process kinetics through electrochemical techniques. Results demonstrate that carbon fibers and carbon felts materials are suitable as anode materials as these materials could be efficiently inoculated in less than 20 days, achieving proper current outputs.

Carbon materials also are employed as cathode electrode. Here, oxygen reaction reduction (ORR) is one of main bottlenecks to use these materials for air-cathode electrodes. In this study, air cathodes based on carbon nanofibers (CNFs), acting as a support matrix for metal nanoparticles (Co and Fe) that act as catalysts, were developed. Air cathode materials were fabricated using electrospinning technique followed by a thermal treatment. ORR were characterized electrochemically in an abiotic cell. Results indicate that CNFs doped with Fe and Co nanoparticles have proper ORR performance to be use as air-cathode electrodes, with higher performance than Fe doped CNF.

Structure – protonic conductivity correlations in perfluorinated sulfopolymer electrolyte membranes with shorter side chains.

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 234

Dr. Alexey Melnikov [1]***, Mrs. Kamila Mugtasimova*** [2]***, Mr. Andrey Rychkov*** [3]***, Mr. Alexander Sivak*** [4]***, Dr. Ivan Ryzhkin*** [5]***, Prof. Vitaly Sinitsyn*** [6]

1. *Institute of Prolems of Chemical Physics RAS, ul. Academica Semenova 1, 142432, Chernogolovka, Moscow region, Russia; Lomonosov MSU, Leninskie gory 1, 119991, Moscow, Russia; MIPT, Institutskiy per. 9, 141701, Dolgoprudny, Moscow region, Russia.,* ***2.*** *InEnergy Group, Elektrodnaya 12-1, 111524, Moscow, Russia; IGP RAS, Vavilova 38, 119991, Moscow, Russia.,* ***3.*** *Lomonosov MSU, Leninskie gory 1, 119991, Moscow, Russia; InEnergy Group, Elektrodnaya 12-1, 111524, Moscow, Russia.,* ***4.*** *InEnergy Group, Elektrodnaya 12-1, 111524, Moscow, Russia.,* ***5.*** *InEnergy Group, Elektrodnaya 12-1, 111524, Moscow, Russia; ISSP RAS, Academician Ossipyan 2, 142432, Chernogolovka, Russia.,* ***6.*** *Institute of Prolems of Chemical Physics RAS, ul. Academica Semenova 1, 142432, Chernogolovka, Moscow region, Russia; ISSP RAS, Academician Ossipyan 2, 142432, Chernogolovka, Russia.*

Proton-conducting membranes were obtained by solution casting method from new ionomer Inion (Russian analog of Aquivion). Obtained membranes were annealed for 20 h at different temperatures (at temperature range from 100 ºC to 220 ºC). The structures of all experimental samples were investigated by small-angle X-ray diffraction methods. It was shown, that the ionomer peak, corresponding to the formation of cylindrical structures, could be observed only above $T_{an} \geq 130$ ºC. With the increase of annealing temperature up to 190 ºC and higher ionomer peak shifted towards smaller angles, that indicated the formation of broader cylindrical channels (Fig. 1). Also it was shown that higher annealing temperatures led to significant increase of specific proton conductivity, measured at different temperatures (20, 30,50 and 70 ºC) and 100% relative humidity. This increase was observed up to $T_{an} = 170$ ºC, where specific proton conductivity reached its maximum and then drastically fell down (Fig. 2). The membranes, annealed at $T_{an} = 170$ ºC demonstrated the values of specific proton conductivity even higher, than those of commercial membrane Nafion NR212 and the activation energies, calculated from the temperature dependences conductivity were about $E_a \approx 0.1$ eV, which is much less than those of a membrane based on Nafion NR212, where E_a is about 0.25 eV.

In this case, our investigations showed that the transport characteristics and dielectric properties of water in nanopores strongly depend on the membrane morphology and its pore size. In this connection, it can be assumed that the lower activation energy E_a and higher values of specific proton conductivity of prepared polymer samples may be due to a smaller diameter of the proton transport channels in the matrix of such a polymer than the diameter of the Nafion NR212 polymer channels. The theoretical model was proposed, according to which a decrease in the dimensions of the channels leads to an increase in the concentration of bond defects and, consequently, to a decrease in the activation energy E_a of the migration process, which was observed in our investigations.

The work was performed under the project No. 17-79-30054 Russian Science Foundation.

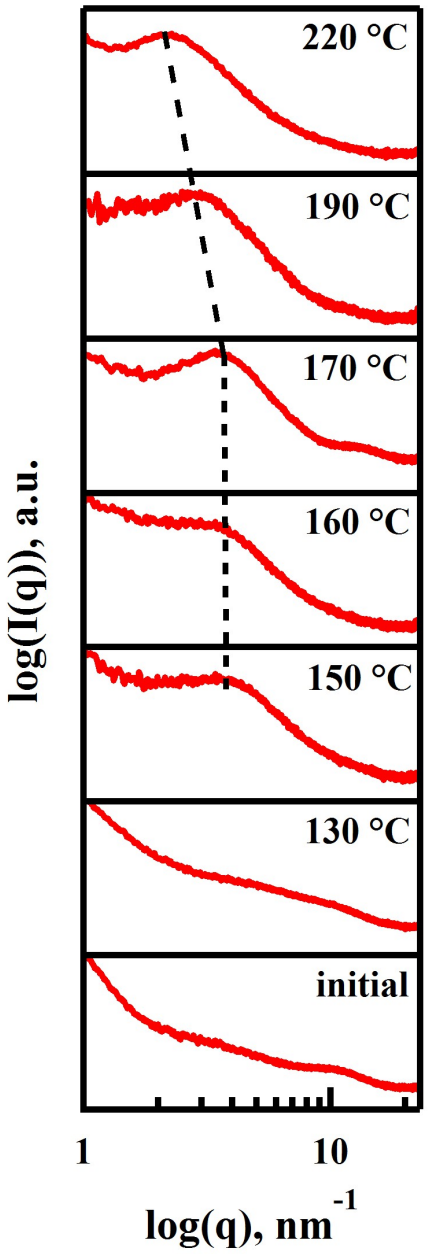


Fig 1.jpg

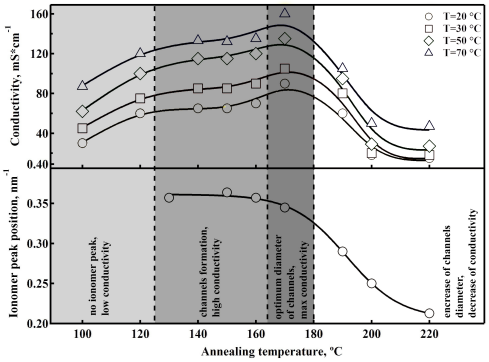


Fig 2.jpg

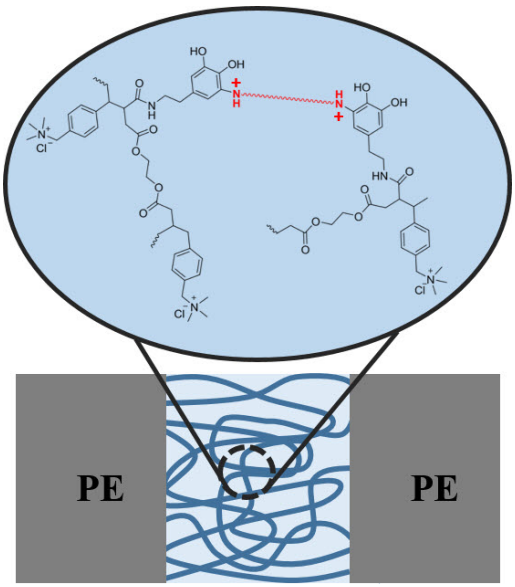
Characterization of Anion Exchange Membrane Using Dopamine Methacrylate for Reverse Electrodialysis

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 385

Dr. JIYEON CHOI [1], ***Dr. SEUNGCHEOL YANG*** [1], ***Dr. NAM-JO JEONG*** [1]

1. *Korea Institute of Energy Research*

Introduction Reverse electrodialysis (RED) can be used to generate renewable energy from the mixing of water of two different salinities. Herein, we have focused on anion exchange membranes (AEMs) for RED, because these significantly affect RED performance parameters such as power density and open circuit voltage. Particularly, dopamine methacrylate (DMA) was used as a supplementary monomer for introducing quaternary ammonium (QA) groups, because the addition reaction of catechol-bearing DMA binds amines. For membrane fabrication, we chose the pore-filling method. Method Microporous polyethylene (PE; porosity 40 vol.%, thickness 22 μm) was used as a substrate. The electrolyte for substrate filling (E4C1; 50% (w/v) in ethanol) comprised vinylbenzyl trimethyl ammonium chloride as the source of the anion exchange groups, ethylene glycol diacrylate as a cross-linker, and DMA (hereafter E4C1). The PE substrate was immersed in the E2C1 solution and cured by UV irradiation for 10 min. The resulting coating was removed and subsequently immersed in a diamine solution of piperazine (PI; 10 mM) or hexamethylenediamine (Hx; 10 mM) for 10 min at room temperature to induce the formation of the supplementary QA by binding with the DMA groups. The resulting membrane was characterized using thermogravimetric analysis (TGA), swelling degree, and area resistance. Results and Discussion TGA results showed two peaks at 174 and 208 °C for the treated membranes, which corresponded to the degradation of the QA groups. A single peak at 214 °C was observed in the sample before diamine treatment. Moreover, after PI and Hx treatment, the swelling degrees (%) were 23.4 and 12.2, respectively, and that of the control membrane (E4C1) before diamine treatment was 20.8. The area resistance of E4C1-PI and E2C1-Hx was 0.404 and 0.421 Ω·cm2, respectively. The change in the swelling degrees was attributed to the penetration of hydrated ions through the AEM, which consequently influenced the area resistance. Conclusions We successfully characterized the pore-filled AEM using DMA and diamine, and expect that E4C1-diamine membranes can be used as an alternative membrane for RED systems.



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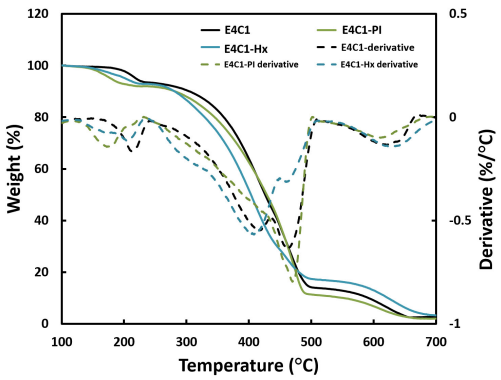


Fig2e4c1-pi hx tga.jpg

Features of the heat release element fabrication process based on thermite materials for thermoelectric devices

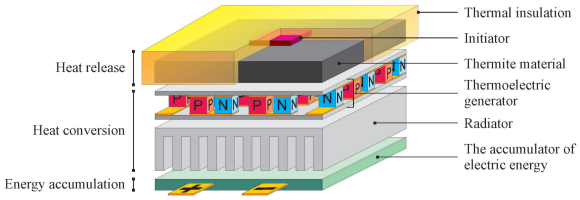
Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 300

Mr. Egor Lebedev [1]***, Ms. Svetlana Nemtseva*** [1]***, Ms. Larisa Sorokina*** [1]***, Prof. Dmitry Gromov*** [1]***, Mr. Artem Sysa*** [2]***, Prof. Sergey Gavrilov*** [1]

1. *National Research University of Electronic Technology,* ***2.*** *Scientific-Manufacturing Complex "Technological Centre"*

Thermoelectric energy converters are an integral part of a large number of electric power supply systems and are used in various devices, ranging from travel equipment to space vehicles. Such converters are characterized by ecological purity and reliability, which is determined by the simplicity of the device and the absence of moving parts. As a source of heat, not only hydrocarbon or radioisotope fuels can be used, but also termite materials, the success of which is limited by the relatively high energy of the initiation of the chemical reaction. In this paper, we consider the features of the process of creating the main element of heat generation on the basis of Al-Ni-FeO_x traditional powder thermite materials. The results of experimental studies of the influence of the pressing force and the composition of powder mixtures on the combustion front propagation velocity and to the magnitude of the thermal effect are presented. Studies were carried out using high-speed video and differential scanning calorimetry.

In addition, the original method for creating an initiator based on Al-CuOx powder material by electrophoretic deposition is described. The paper presents the results of experimental studies of the effect of the suspension composition and electrophoretic deposition regimes on the structure and composition of precipitation and deposition rate. The results of measuring the combustion front propagation velocity using high-speed video are also presented.



2.jpg

Evaluating the efficiency of Building Heat Networks in Social Housing

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 370

Ms. Victoria Aragon [1], ***Mr. Julian David Quintero*** [1], ***Dr. Stephanie Gauthier*** [1], ***Prof. Patrick James*** [1], ***Prof. AbuBakr Bahaj*** [1]

1. *University of Southampton*

Centralised heating systems and building heat networks are seen as a cost-effective and efficient method of heating supply and are encouraged by the UK's government schemes to reduce carbon emissions and assure residents can afford heating their homes. Hence, the UK's, specifically England's domestic building stock is being retrofitted to upgrade heating systems, with particular focus in social housing. Social housing represents 17% of buildings in England and hosts low-income residents, who could greatly benefit from affordable heating. Thus, it is important to understand the characteristics of the demand and the factors that affect the performacnce of heat networks, to assure an efficiency heat supply and occupants' comfort. This papers presents research conducted on five identical high-rise social housing tower blocks located in the city of Southampton, United Kingdom and recently refurbished to meet BREEAM Excellent standards. Heating in each tower block is supplied through a high temperature wet network from gas boilers to heat exchangers in each flat. Monthly gas consumption at building level and heating demand for space heating and hot water at flat level were monitored from 2013 to 2017. Results showed that: (a) the efficiency of the heat network was lower than 70% at all times, reaching minimum values during summer months (b) the heat demand in the flats was lower than expected for the building characteristics – 34 kWh/m^{2}year for hot water and 21 kWh/m^{2}year for space heating, (c) heat demand variability was higher during the period from November to January. The analysis identifies building thermal performance, layout of the heat network, and resedents' comfort requirements and financial limitations as the main determinants of heat demand.

Mechanical, transport and crossover properties of aquivion type proton-exchanged membranes

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 244

Dr. Alexey Melnikov [1]***, Mrs. Kamila Mugtasimova*** [2]***, Mr. Andrey Rychkov*** [3]***, Mr. Alexander Sivak*** [4]***, Prof. Vitaly Sinitsyn*** [5]

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The solution casting technology was applied to manufacture thin polymer films (~20-30 microns) from the ionomer solution of perfluorinated polymer with short side chains (an analogue of the commercial polymer Aquivion®). The influence of annealing temperature on the mechanical properties (elastic limit) and proton conductivity were investigated. The elastic limit and proton conductivity of the samples were found to reach their maximum values at the annealing temperature 170 ± 5°C. The protonic conductivity values of prepared Aquivion-type membrane occur comparable with the conductivity of commercial Nafion membrane in whole temperature range of measurements. The gas permeability of the membrane (i.e. crossover) was measured by the method of leakage, which showed that the crossover of Aq170 membrane did not exceed 1.1 mA/cm^2. This value is fully consistent with the standard set by the DOE electrochemical community (Fuel Cell Technical Team Roadmap) according to which the membrane crossover can not exceed 2 mA/cm^2. Comparative studies of membrane electrode assemblies (MEA) using the commercial (Nafion 212) and solution-casted membranes were carried out. MEA with optimized Aquivion-type membranes showed satisfactory values of performance characteristic. Taking into account high decomposition temperature of Aquivion-type membranes in compare with Nafion, we can conclude, that solution-casted membrane obtained in this study is promising for usage in middle-temperature (above 100°C) fuel cells. The work was performed under the project No. 17-79-30054 Russian Science Foundation.

Processing of Prussian Blue-type Oxygen Evolution Electrocatalysts

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 164

Mrs. Li-juan Han [1]***, Mr. Pengyi Tang*** [2]***, Dr. ÁLvaro Reyes*** [1]***, Dr. Bárbara Rodríguez*** [1]***, Dr. Mabel Torréns*** [1]***, Prof. Joan Ramón Morante*** [3]***, Prof. Jordi Arbiol*** [2]***, Prof. José ramón Galán-mascarós*** [1]

1. *Institute of Chemical Research of Catalonia (ICIQ),* ***2.*** *Catalan Institute of Nanoscience and Nanotechnology (ICN2),* ***3.*** *Catalonia Institute for Energy Research (IREC)*

Water oxidation is considered the bottleneck in the development of an efficient and cost-effective water splitting technology. State-of-the-art water electrolyzers are still far from being competitive with steam reforming, the cheap and well-established hydrogen production scheme from fossil fuels. One of the challenges resides in substituting the expensive noble metal catalysts by earth-abundant counterparts while maintaining the efficiency and performance required for technological applications. Inexpensive transition metal oxides are very competitive catalysts for the oxygen evolution reaction (OER) but exclusively in alkaline media. We have discovered in our labs the unparalleled OER activity offered by Prussian blue analogues. These coordination polymers are robust in the solid state, stable and active in a large pH range (0 < pH < 11), appearing as a unique alternative based on abundant and inexpensive metals. In this communication, we will present our latest results and advances in the processing of these coordination networks for their implementation into water splitting devices.

Laccase-mediator assisted enzymatic hydrolysis of aqueous ammonia soaking pretreated sugarcane bagasse at high solids concentration and fermentation to bio-ethanol by Candida tropicalis

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 171

Mr. Kanak Raj [1]

1. *IIT Madras*

The most important step in bioethanol production process is enzymatic hydrolysis of lignocellulosic biomass to fermentable sugars. Production of >5% ethanol during fermentation is desirable for economically sustainable bioethanol production process, which requires a minimum of ≥10% fermentable sugars in the hydrolysate. Formation of 10% fermentable sugars, mostly glucose and xylose from lignocellulosic biomass has been reported for enzymatic hydrolysis at ≥20% solids loading of lignocellulose. Enzymatic hydrolysis at high solid loadings involves certain challenges such as high stirring resistance in bioreactor and limitation of mass and heat transfer which results in reduced hydrolysis yields. In the present work fed-batch process has been optimized for biomass feeding time and enzyme loading to achieve >20% solid loading of low temperature aqueous ammonia pretreated sugarcane bagasse. Laccase – mediator assisted enzymatic hydrolysis was performed to enhance the sugar yields. The present method improved yields of sugars when compared with cellulase hydrolysis. The ethanol titer obtained from the biomass hydrolysate was more than 60 g/L. The ethanol concentration achieved in our study was higher than the level reported for 2nd generation bioethanol produced from ammonia soaking pretreated biomass. The results also proved that low energy pretreatments also have the potential to produce high titer of bioethanol

Biodiesel production from a novel Halotolerant Oleaginous Yeast

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 253

Ms. Megha Bedi [1]

1. *IIT Madras*

Biodiesel is an attractive substitute for petrodiesel due to its sustainability and environmental friendliness. Currently, for commercial biodiesel production bio-lipids extracted from edible vegetable oils are employed but are not sustainable. As an alternate microbial diesel particularly from oleaginous yeasts is an attractive solution as it offers features like high growth rate, high oil productivity on wide variety of substrates and can be produced in small land space. In the present study, soil samples having detritus matter were collected from IIT Madras campus, and Pichavaram mangrove. Samples were enriched in high C/N ratio (40), and chloramphenicol containing media to select yeast strains. Forty yeast strains were isolated and tested for oleogenicity, by growing in C/N ratio 75 medium. Total lipids accumulated after 96h of growth were estimated by primary screening using Sulpho phospho vanillin assay. Secondary screening was done by gravimetric estimation using chloroform-methanol extraction, 35 strains had total fatty acid content (TFA) below 25%, four strains had TFA between 25-35% and one isolate OE21 accumulated carotenoids and lipids up to 50% of dry cell weight. Organism producing carotenoids are advantageous as carotenoids render oxidative stability to biodiesel. The isolate grew in sea water exhibiting halotolerance, a property useful for large scale cultivation. Therefore, isolate OE21 appears to have potential for large scale production even though there are yeasts producing over 60-70% lipids. FAME (Fatty acid methyl ester) profile of OE21 was determined using GCMS (Gas chromatography- Mass spectrometry) obtained by direct transesterification of the lyophilized cells. From this FAME profile the five essential physical properties of biodiesel were predicted using empirical equations reported by Luis et. al. 2012. A high Cetane number (66.53), low kinmatic viscosity (4.57mm^3/s), low density (0.87g/cm^3), higher heating value (39.80 MJ/kg) and Iodine Value (53.60 mg I_2/100g) were obtained and were found to cohere to ASTM 6751-08a standard recommendations. Results suggested that lipids from OE21 is of suitable quality for biodiesel production.

Comparative studies of Cu-Cl Thermochemical Water Decomposition Cycles for Hydrogen Production

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 278

Dr. Funmilayo Osuolale [1], ***Dr. Oladipupo Ogunleye*** [1], ***Ms. Mary Fakunle*** [1], ***Mr. Abdulfataah Busari*** [1], ***Ms. Yetunde Abolanle*** [1]

1. *Ladoke Akintola University of Technology, Ogbomoso*

Hydrogen is a potential alternative that has been viewed as a promising fuel with some unique characteristics that makes it an ideal energy carrier that can satisfy all energy needs. Achieving the energy –source goal of hydrogen requires its production from a non-fossil fuel source and on a large scale. Thermochemical water decomposition is an emerging technology for large-scale production of hydrogen. About 200 thermochemical cycles have been identified but the copper–chlorine thermochemical cycle is regarded as one of the most promising approaches. A 3-step, 4-step and 5-step cycles of Cu-Cl system for thermochemical water decomposition cycles have been studied extensively but there is need for comparative studies that can aid in decision making on the most effective and efficient step cycle especially with respect to the second law efficiency of the process.

This research focus on thermodynamic analysis of the copper chlorine cycles. The cycles were simulated using Aspen Plus software. All thermodynamic data for all the chemical species was defined from literature and the reliability of other compounds in the simulation was compared with some other sources such as HSC chemistry software. The 5-step Cu–Cl cycle consist of five steps; hydrolysis, decomposition, electrolysis, drying and hydrogen production. The 4-step cycle combines the hydrolysis and the drying stage of the 5-step cycle to eliminate the intermediate production and handling of copper solids. The simulation of the 3-step cycle is presented in Figure 1. An optimisation procedure was conducted for the 3-step case. The optimisation objective was the exergy efficiency. Bootstrap aggregated neural network (BANN) was used to enhance model accuracy and prediction.

The results of the analysis gave 59.64%, 44.74% and 78.21% for the 5-step cycle, 4-step cycle and 3-step cycle respectively. Parametric studies were conducted and possible efficiency improvement of the cycles were found to be between 59.57-59.67%, 44.32-45.67% and 23.50-82.10% for the 5-step, 4-step and 3-step respectively.

The results from the parametric analysis of the simulated process will assist ongoing efforts to understand the thermodynamic losses in the cycle, to improve efficiency, increase the economic viability of the process and to facilitate eventual commercialization of the process.

Nowcasting the Output Power of PV Systems

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 306

Prof. Marius Paulescu [1], ***Dr. Oana Mares*** [2], ***Dr. Ciprian Dughir*** [2], ***Dr. Eugenia Paulescu*** [1]

1. *West University of Timisoara,* ***2.*** *Politehnica University of Timisoara*

Unlike the power generated by traditional power plants based on fossil or nuclear fuels, the output power of the photovoltaic (PV) plants is highly variable to erratic. This is due to passing clouds which may cause a fast variation of the solar irradiance, further inducing a massive shift in the output power of a PV plant. In this context, forecasting the power generated by PV plants becomes a critical task in the smart management of the grid. Accurate forecasts will enable the computers to take control actions aiming to balance the power grid in real-time. Since there are circumstances when the fluctuations of the solar irradiance are on a time scale of minutes or less, nowcasting the output power of PV plants becomes a timely research area.

This paper presents an innovative procedure for nowcasting the output power of a PV plant. The procedure involves two interrelated issues: (1) realistic modeling of the PV converter response and (2) forecasting the solar resource availability. The basic concept of the proposed procedure is based on several innovative results obtained by our team: (1) a new procedure of solving the five-parameter model of a solar cell (Mares et al. Energ Convers Manage 105 (2015) 139); (2) accurate modeling of the PV module operation in real environmental conditions (Paulescu et al. Energy 70 (2014) 49) and (3) the innovative two-state model for short-term forecasting solar irradiance (Paulescu et al. Energ Convers Manage 79 (2014) 690) based on sunshine number, a binary quantity stating whether the Sun is shining or not. The study was conducted with data recorded on the Solar Platform of the West University of Timisoara, Romania (http://solar.physics.uvt.ro/srms). The built database contains radiometric, meteorological and electrical data from an experimental PV setup, all measured simultaneously at high resolution (15 seconds).

Composite materials of Ti-doped strontium ferrite and ceramic electrolytes as both the anode and cathode in symmetrical solid oxide fuel cells

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 94

Dr. Tae Woo Kim [1], ***Mr. Minjoon Kwak*** [1], ***Dr. Hyun-jong Choi*** [1], ***Mr. Doo-won Seo*** [1], ***Dr. Sang-kuk Woo*** [1], ***Dr. Sun-dong Kim*** [1]

1. *Korea Institute of Energy Research*

Compared to traditional solid oxide fuel cells (SOFCs), symmetrical solid oxide fuel cells (SSOFCs) have attracted great attention because of several advantages as follows; the mechanical and chemical compatibility between the electrolyte and electrodes by reducing the number of different cell components and interfaces and much easier production of SSOFC because of assembly of the electrolyte and electrodes from just one thermal process, reducing fabrication time and costs. Among the redox stable electrode candidates, high valence metal ion-doped strontium ferrites, M-doped SFOs (M= Ti^{4+}, Si^{4+}, Zr^{4+}, Mo^{6+} and W^{6+}), were reported to possess high redox stability in a wide range of temperatures and oxygen partial pressures. In particular, Ti-doped SFO is one of the most promising materials due to its relatively low polarization resistance and chemical compatibility with different electrolytes (i.e., GDC, LSGM). In this regard, we used composite electrodes of Ti-doped SFO and different electrolytes (i.e., YSZ, GDC, LSGM, and LSGMZ) for both cathode and anode in SSOFCs in order to improve electrochemical performances. First, $Sr_{0.8}Fe_{1-x}Ti_xO_{3-\delta}$ (x=0.2) was prepared by solid state reaction. The doping of Ti in SFO was confirmed by various tools such as powder X-ray diffraction, energy dispersive spectroscopy, x-ray absorption spectroscopy and so on. The composite materials of SFTO and different electrolytes were prepared by mechanical mixing using a ball miller and subsequent heat treatment. Among electrolytes used, it was confirmed that YSZ is not suitable for use as an electrode material because of an occurrence of secondary phases, evidenced by PXRD. Among the others, the composite composed of SFTO and LSGMZ exhibited the highest efficiency operating as both cathode and anode with polarization resistance values of 0.3 Ω/cm^2 in cell condition test at 750 ^oC. The SSFC consisting of LSGMZ electrolyte and symmetric SFTO/LSGMZ composite electrodes showed a maximum power density of 500 mW/cm^2 at 750 ^oC. In this presentation, we will discuss our recent efforts in using the composite electrodes in SSFC, which include a synthesis procedure of materials, structural redox stability, and electrochemical performance.

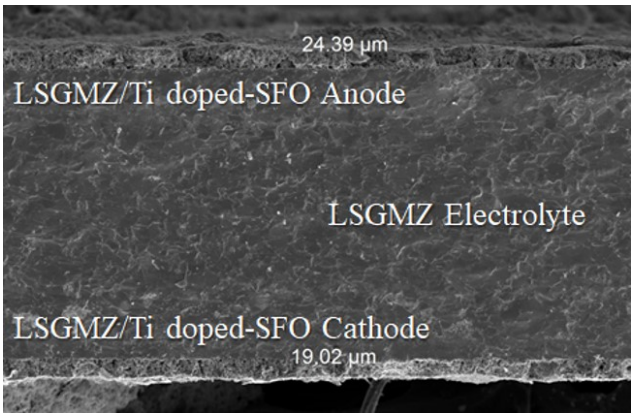


Figure1.jpg

The effect of nanolayer of cathode on cell performance in Molten Carbonate Fuel Cells

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 64

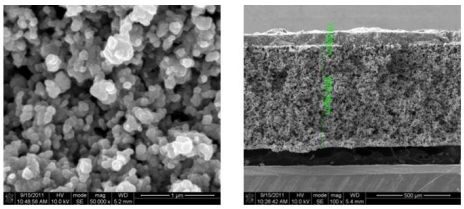
Dr. Shin Ae Song [1], ***Dr. Kiyoung Kim*** [1], ***Dr. Sung Nam Lim*** [1]

1. *Korea Institute of Industrial Technology*

Fuel cell is one of the best solutions for distributed powder for the city. Among many types of fuel cells, molten carbonate fuel cell (MCFC) operated at high temperature (650 °C) has been studied intensively due to no necessity of using expensive noble metal catallysts and variety of fuel selection. However, MCFC has the relatively lower cell performance than that of SOFC(solid oxide fuel cell). The oxygen reduction reaction (ORR) in cathode is considered much slower that the hydrogen oxidation reation in anode. To enhance the cell performance of MCFC, new cathode has to be developed.

In the present study, the effect of nano NiO layer on cathode on cell perfoance in MCFC is examined. To increase cell performance, increasing the active area in electrode is very important. However, the attempt on increase reaction layer in electrode have been little in MCFC area yet.

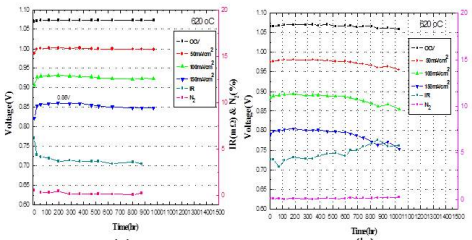
For the formation of reaction layer, nano lithiated NiO powder was prepared as following method. the nano Ni powder (70 nm size, 10m^2/g surface area) and lithium nitrate was mixed by 1:1 mole fraction in mortar, and then was heated at 650 °C 3hr in air atmosphere. The surface area of as-prepared nano lithiated NiO powder is 7m^2/g. The ORR can occur in whole surface area of applied nano lithiated NiO layer, the area of reaction layer is about 12m^2/g when coating nano lithiated NiO of 10wt%. The surface area of conventional lithiated NiO electrode used as cathode is 0.48 m^2/g. the thin layer were prepared after nano lithiated NiO coating. the thicknesses of the thin layers at 5wt% coating and 15wt% coating are 24 and 78 um, respectively. The cell performance of cell with nano lithated NiO is 0.86V at 620 °C. It is very high value as comparing that of uncoated cathode, 0.78V. As shown in EIS results, the charge transfer resistance were reduced dramatically after nano lithiated NiO coating. It shows that enlarging reaction area in cathod via the formation of reaction layer by coating nano lithiated NiO powder certainly enhances the cell performance.



(a) (b)

Figure 1. The SEM images of (a) nano lithiated NiO powder and nano lithatied NiO coated cathode

Figure1.jpg



(a) (b)

Figure 2. Cell performance using (a) nano lithiated NiO coated cathode and (b) uncoated cathode

Figure2.jpg

Band gap dispersion of Pb-free double perovskites induced by metal cation ordering

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 270

Prof. Ki-Ha Hong [1]

1. *Hanbat National University*

Metal halide perovskites (MHP) attract broad interests in the fields of next-generation photovoltaic material developments. Since the Miyasaka group first implemented methylammonium (MA, $CH_3NH_3^+$) lead tri-iodides ($MAPbI_3$) as a sensitizer in dye-sensitized solar cells, there have been dramatic increases in the power conversion efficiency (PCE) of perovskite-based solar cells, of which the certified PCE has already exceeded 22%. However, stability and toxicity are main concerns for MHP solar cell commercialization. Recently, there have been much effort to develop Pb-fee perovskites by expanding the concept of common perovskite lattice family. Double perovskite is one of the promising candidates for Pb-free MHPs which can be made by replacing two divalent Pb^{2+} ions with one monovalent M^+ and one trivalent M^{3+} ions ($A_2M^+M^{3+}X_6$).

Although there have been many theoretical and experimental studies on the development of dual perovskites, the importance of the sequence of metal cations has not been examined. This study presents the electronic structure changes induced by metal cation ordering of double perovskites through density functional theory calculation. The band gaps of double perovskites are significantly influenced by metal cation ordering. Hybrid density functional calculation including spin orbit coupling predicts that the band gaps can be modulated by even 2 eV for a unit cell configuration of $Cs_2BiAgCl_6$. This study reveals the importance of the cation alignment control and suggests the physical origin of the band gap dispersion of double perovskites.

Electric field distribution in PV modules

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 75

Prof. Vladimir Saly [1], ***Dr. Milan Perný*** [1], ***Dr. Vladimír Ďurman*** [1], ***Dr. Michal Váry*** [1], ***Prof. František Janíček*** [1]

1. *Slovak University of Technology*

Introduction

Compact photovoltaic module is a layered structure consisting of interconnected and encapsulated solar cells embedded between substrat and superstrat (back and front sheets), glass or plastic sheets, in order to create compact and sealed unit protected against environmental influences. Solar cells strings are encapsulated between two sheets of encapsulant foil. In the case of many solar cells connected into series, the encapsulant is electrically stressed mainly at sharp edges of the structure. Another source of enhanced electric field is accumulation of space charge at the dielectric – electrode interfaces. This phenomenon is connected with the electrode polarization [1]. In the process of polarization the free cations in dielectric are accumulated near the negative electrode, creating a positive charge. A similar process runs near the positive electrode. The steady state of accumulation is given by the balance of concentration gradient and the Coulombic (electric) force [2, 3].

Methods

Interfacial processes were studied in various insulation foils intended for encapsulation of photovoltaic cells. The analysis was based on the dielectric measurements in a broad region of temperatures and frequencies. The measurements showed that the observed processes are connected with the electrode polarization. The electrode polarization gives rise to the space charge formation and enhancement of electric field near the electrodes.

Results and Discussion

Calculation of the electric field is important for praxis as it allows assessing the risk of electrical break-down. In our work we use the parameters obtained from the dielectric meas-urements for calculation of electric field distribution in encapsulating materials. It was found that electric field increases more than 100-times comparing with the mean value.

Dielctric parameters permittivity ε, conductivity σ, thicknesses of Debye layer assigned as h_1 and the bulk layer h_2 and electric field ratio E_1/E_2 which equals to s_2/s_1 are in Tab. 1. for various temperatures.

Table 1. Dielectric parameters of PVB encapsulating foil

t (°C)	ε_∞	ε_s	τ_0 (s)	σ_1 (10^{-12} Sm^{-1})	σ_2 (10^{-9} Sm^{-1})	h_1 (10^{-7} m)	h_2 (10^{-4} m)	E_1/E_2
39	5.76	8.76	0.176	4.43	0.51	4.57	3.60	54
45	5.76	8.67	0.118	6.14	0.89	1.81	3.60	144
52	5.75	8.56	0.075	6.34	1.65	1.06	3.60	260
58	5.75	8.47	0.052	7.46	2.75	0.78	3.60	369
63	5.74	8.40	0.039	8.91	4.16	0.64	3.60	466
69	5.74	8.32	0.027	1.13	6.70	0.52	3.60	590
75	5.73	8.24	0.020	1.47	10.60	0.44	3.60	722

Table.png

Effects of Absorber Geometric Pattern on the Thermal Performance of a Solar Water Heating System

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 141

Dr. Farayi Musharavati [1], ***Dr. Khaled Ibrahim*** [1], ***Mr. Rahib Khan*** [1], ***Dr. Samer Gowid*** [1]

1. *Qatar University*

The effects of a multichannel absorber geometric pattern on thermal performance of a solar water heating system was investigated. Research has shown that the water flow pattern inside the absorber is determined by the geometric pattern of the absorber and has a significant influence on the thermal performance of solar thermal collectors. In order to determine the effect of geometric patterns, a number of multichannel layout arrangement were investigated through CFD simulations. A more effective layout (mosaic arrangement) of the multichannels was identified. In order to investigate the influence of the flow distribution through the mosaic absorber, two collector designs that differ in layout of multichannels were investigated. The first pattern was based on parallel arrangement of the multichannels in which water flows following the traditional serpentine pattern. The second pattern was a mosaic arrangement of the multichannels, in which water flows from one end of the collector towards the center until it eventually flows out near the center of the collector. The effects of these absorber geometric patterns on the thermal efficiency and stratification of water in an aluminum storage tank were investigated. The overall efficiency was found to be 56% for the serpentine multichannel collector, while that for the mosaic arrangement was found to be 65%. The solar fraction averaged 0.58 and 0.62 for the serpentine multichannel collector and the mosaic multichannel collector respectively. The maximum useful volume from the 100-litre storage system was found to be 75 litres for both collector designs. The average heat loss coefficient of the storage tank was found to be 0.6 W/K. The self-discharge time of the system was found to be 23 hours. These results show that the mosaic multichannel arrangement is more efficient. Hence, it can be concluded that the absorber geometric pattern has an influence not only on the collector efficiency but also on hot water storage system.

Acknowledgements This research was made possible by a NPRP award NPRP 5-161-2-053 from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the authors.

The Effects of Risk Management on Bioenergy Projects

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 162

Mr. Aminu Bature [1], ***Mr. Jahangir Akhtar*** [1], ***Dr. Lynsey Melville*** [1], ***Dr. Khondokar Mizanur Rahman*** [1], ***Mrs. Poonam Aulak*** [1]

1. *Birmingham City University*

Introduction: The sheer volumes of research studies indicate that effective risk analysis has a profound effect on the early financing stages of bioenergy and other renewable energy projects, its investments, and the decision-making mechanism for risk transfer to adopt. However, there are little research data for project developers to utilize during initiation and planning phases of these projects. A better understanding of the risks associated with bioenergy projects can help policy makers, project developers and risk management experts to deploy more clean energy. **Methods:**In this study, the researchers focus on the quantitative used of online survey method. Questionnaire was develop using online survey portal and the survey web link emailed to participants who are involved in renewable energy projects and risk management followed by an in-depth comparative analysis between the collected primary data and the secondary research information gathered from relevant existing literature.**Results:** The study found that, the risk factors most associated with bio-energy projects are; economic (flagged by 47.73%) and environmental risks (flagged by 45.45%). These outcomes are consistent to the International Energy Agency IEA findings that economic and socio-environmental risks have the highest impact on Return on Equity (ROE) and debt-leverage capability of biomass technologies and projects. **Discussion:**The effects of risk management on bioenergy projects begins from initiation and planning stages (that is, to attract investment and avoid negative financial impact on the projects). Moreover, in project implementation it plays an instrumental role of identifying, controlling and mitigating inherent risk to boosts project success. It was recommended that bioenergy project managers and developers should use systematic risk management methods such as RBS (Risk Breakdown Structures) for better risk identification during the risk management cycle.

Gasifier SE-01 Produce Renewable and Sustainable Energy Ecosystems: Utilization of Agricultural Waste with H2 Results as Clean Energy and Biobriquette

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 22

Mr. Sucipto Halbianto adi [1], ***Mr. Lutfi Alfianto*** [2], ***Mr. Muhamad Naufal Dzaky*** [2], ***Mr. Abdurrahman Muhammad Fikri Rasdi*** [3]

1. *Universitas Gadjah Mada/Department of Electrical Engineering,* ***2.*** *Universitas Gadjah Mada/Department of Aquaculture,* ***3.*** *Universitas Gadjah Mada/Department of Agricultural Microbiology*

In Indonesia, the abundance of agricultural waste in the form of rice husks of post-harvest results are still not optimal utilization. Whereas, the condition of cellulose solid waste is very useful that can produce renewable energy sources such as biogas, biobriquette, and biofuel. One of the optimization of agricultural waste utilization in the form of rice husks and corn cobs into biogas is by using gasifier. Gasifier is one of the tools or reactor which converts cellulose solid biomass into gas (CO, CH_4, CO_2 and H_2) by gasification method. In general, the benefits of gasifiers are used as a producer of thermal energy and electrical energy. But the constraint of the current gasifier tool is still leaving the gas residue content of CO or TAR, thereby reducing the calorific value of thermal energy generated. Gasifier SE-01 is a gasifier innovation that can produce clean H_2 gas without TAR. Gasifier SE-01 has a concept of work as follows, biomass in – water seal PIT – reduction chamber – heat exchanger – charcoal out. Gasifier SE-01 aims to realize the renewable energy ecosystem in the agricultural environment, namely the result of H2 gas as gas fuel energy and electric energy (electric energy to drive motor drying post-harvest agricultural waste) TAR liquid waste is used as a termite medicine, while the residual charcoal solid waste of combustion is used as biobriquette.

Chemical transformation of SnSe bulk crystals to Se nanowires and their thermoelectric application

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 211

Dr. Hyun Ju [1], ***Mr. Taeseob OH*** [1], ***Prof. Jooheon Kim*** [1]

1. *Chung-Ang University, School of Chemical Engineering & Materials Science*

Se nanowires are one of the chalcogenide-based nanostructures that have attracted interest in various research fields because of their unique characteristics. Herein, we report on the fabrication of Se nanowires from bulk SnSe crystals through an organic acid-assisted chemical transformation process. During the reaction process, the concentration of organic acid is critical to control the morphology of final products. Se nanowires with the diameter of ~40 nm and length of ~1 μm are obtained after the transformation, and we suggest reaction mechanism for the chemical transformation of SnSe. The effect of Se nanoparticles on the thermoelectric behaviors in SnSe is also investigated and discussed. The Se nanowires and Se/SnSe composite in this study will open up new possibilities to various applications with excellent performances

Evaluation of a hybrid system to improve the electrical efficiency in photovoltaic panels.

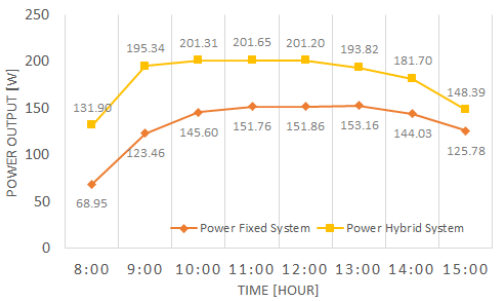
Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 314

Mr. Juan Camilo Valencia [1], Mr. Mauricio Díaz [1], Mr. Carlos Andrés Giraldo Castañeda [1]

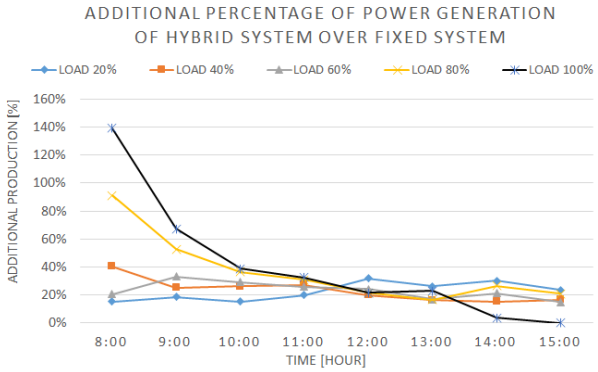
1. *Pontificia Universidad Javeriana Cali - College of Engineering*

This project shows a photovoltaic hybrid system (PHS) that follows the sun using electronic and mechanical devices and reduces the solar panel's temperature with water in order to increase the energy obtained.
The system was designed and implemented with a 1-axis solar tracker system (TS) and a water cooling system (WCS). The main goal was to improve the electrical efficiency conversion increasing energy production through the day. PHS allows solar radiation beams to fall almost perpendicularly and decreases the temperature of the solar panel. Finally, its performance is compared against a traditional fixed photovoltaic system (FPS) oriented at 15° facing south.
The PHS and FPS were fully characterized on an embedded microcontroller. The variables measured were solar radiation, voltage, current, temperature and position. Experiments were made during seven days between December 1st and December 19th 2017 in the city of Güadalajara de Buga, Valle del Cauca, Colombia. The test consisted on using the same photovoltaic panels in both PHS and FPS. They were loaded directly with electric loads at 20%, 40%, 60%, 80% and 100% of the total power capacity of the solar panels. All measurements were taken simultaneously.
Results points out that electrical efficiency of the PHS increased 5.03% compared to the FPS in the same environmental conditions. Finally, the PHS shows daily additional average power between 37% and 40% when it is loaded with electric loads of 80% and 100%.

Fixed hybrid systems.jpg



Power generation fixed hybrid system 60 .png



Additional power generation hybridsystem over fixdexsystem.png

Bottom-up engineering of nanoflake and nanowire heterostructures for energy storage and conversion applications

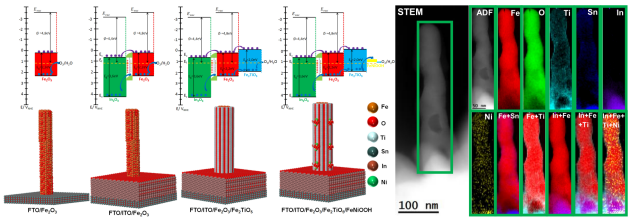
Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 39

Mr. Peng-Yi Tang [1]***, Dr. Hai-bing Xie*** [2]***, Mr. Carles Ros*** [2]***, Mrs. Li-juan Han*** [3]***, Mr. Marti biset Peiro*** [2]***, Prof. Alejandro Perez-Rodriguez*** [2]***, Dr. Edgardo Saucedo*** [2]***, Prof. José ramón Galán-mascarós*** [3]***, Dr. Teresa Andreu*** [2]***, Prof. Joan Ramón Morante*** [2]***, Prof. Jordi Arbiol*** [1]

1. *Catalan Institute of Nanoscience and Nanotechnology (ICN2),* ***2.*** *Catalonia Institute for Energy Research (IREC),* ***3.*** *Institute of Chemical Research of Catalonia (ICIQ)*

In this contribution, honeycomb-like hematite nanoflakes/branched polypyrrole nanowire heterostructures with a 3D complex structure have been synthesized and employed as high-performance negative electrodes for asymmetric supercapacitor applications. The detailed TEM-STEM characterization and deep EELS chemical analysis at the nanoscale has been combined to elucidate the mechanisms underlying the formation and morphology evolution of the core-branch Fe_2O_3@PPy heterostructures for supercapacitor apllication. [1]
On the other hand, we have fabricated ITO/Fe_2O_3/Fe_2TiO_5/FeNiOOH multi-Layers based on nanowire heterostructures via combination of sputtering, hydrothermal, ALD, photo-electrodepositon, methods for water splitting application. Structural, spectroscopic and electrochemical investigations disclose that the origin of the superior water oxidation performance is the interfacial coupling effect of ITO underlayer (Sn doping and conductivity promoter), ultrathin Fe_2TiO_5 coating (Ti doping, energetics and surface state density modulation) and FeNiOOH eletrocatalyst (varying surface state energy level). [2]

References
1 P.Y. Tang et al., Nano Energy, 22 (2016), 189-201.
2 P.Y. Tang et al., Energy & Environmental Science, 10 (2017), 2124-2136.



1.jpg

PV module monitoring system based on low-cost solutions: a Raspberry application and assessment

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 96

Mr. Jose Miguel Paredes-parra [1], Mr. Guillermo Silvente-Niñirola [2], Dr. Antonio Mateo-aroca [2], Dr. Maria del Carmen Bueso-sanchez [2], Dr. Angel Molina-Garcia [2]

1. *Centro Tecnológico de la Energía y el Medio Ambiente,* ***2.*** *Universidad Politécnica de Cartagena*

During the last decade, the integration of renewables into power systems has implied multiple studies and analysis in terms of grid power quality, reliability and/or feasibility. Among the different resources to be considered as an alternative generation, wind and solar sources emerge as the most mature technologies. Indeed, they have been widely integrated in comparison with the rest of solutions and, nowadays, they account for more than 20% of generation in developed countries. With regard to PV installations, monitoring problem requires a detailed analysis, since solar radiation fluctuations, soiling on solar panels or deficiency of PV panel performance can involve unexpected output power oscillations and, subsequently, undesirable power generation decreasing. Therefore, accurate and low-cost solutions to monitor in detail PV power generation is more and more required by the sector. Under this framework, this paper describes a PV module monitoring system based on low-cost solutions, aiming to collect data at PV module level and give detailed information regarding the PV power plant performance. Actually, most current solutions are based on data collected at inverter level, and thus, monitoring solutions at PV solar module are demanded by the operators to overcome typical drawbacks related to large amount of panels to be simultaneously monitored and/or industrial rooftop solar PV plants that become difficult access. Additionally, low-cost monitoring systems are welcome as an alternative way to improve PV module performance and give predictive maintenance solutions. The proposed monitoring system is based on Raspberry systems that allow us to set personalized solutions with powerful hardware and connectivity options. Consequently, meteorological and electrical data are collected from this equipment and sent to a sink node where the information is available. Detailed information of the solution as well as preliminary results collected in a PV power plant connected to the grid are also included in the paper.

NUMERICAL, EXPERIMENTAL AND ANALYTICAL and CFD INVESTIGATION FOR HIGHER WIND TURBINE EFFICIENCY

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 118

Mr. Arulappan Swaminathan [1]

1. *National Institute of Technology*

With an increased efficiency one particular model wind turbine rotor is able to run and produce higher energy output. From a constant air flow source and by placing each of the model rotors in front of the blowing air the rotors are allowed to rotate and tested. The Model rotors are so chosen and made to have various Solidity ratio, Blade angle, Tip Speed ratio and Mass. The energy equation is used and the maximum rotational speed of the rotors under identical conditions are measured using non-contact type optical speed sensor. Astonishingly about 30 to 40 % more energy efficient is the case for a particular rotor geometry is reported. CFD test results are also firmly supports the above final conclusion it is recommended that Commercial wind turbine manufacturers can confidently change the existing wind turbine rotor blade design.

Experimental Study of Numerical Relay for Over-current Protection in Solar Panel for Securing the Hydrogen Production.

Wednesday, 25th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 444

Mr. Chawki Ameur menad [1], ***Prof. Rabah Gomri*** [1], ***Dr. Mohamed Bouchahdane*** [2]

1. *University Mentouri Constantine, 25000 Algeria,* ***2.*** *Department of Power and control Institute of Electrical and Electronic Engineering, IGEE Boumerdes, Algeria*

Every electrical system in solar panel can fail during electrical faults. In this incidence, high fault current can occur. Such current must be interrupted by a protective system. The research was supported by experimental tests. In work conditions close to real, the numerical relay REF542plus was tested for both instantaneous and extremely inverse definite minimum time IDMT over-current protection functions with the help of CMC 365 injection and test equipment associated to Test Universe software. Protecting hybrid solar panels generating by different renewable energy sources for hydrogen production from over-current is very important for improving the energy efficiency in one hand, and securing the function in critical condition from damage of the solar cells in second hand. The contribution of this research is controlling the over-current in the solar panel for securing the continuation of the hydrogen production from renewable energy sources in short time. The obtained results allowed the observation of the relay's behavior when subjected to certain faults; where the solar panel keeps producing the hydrogen.

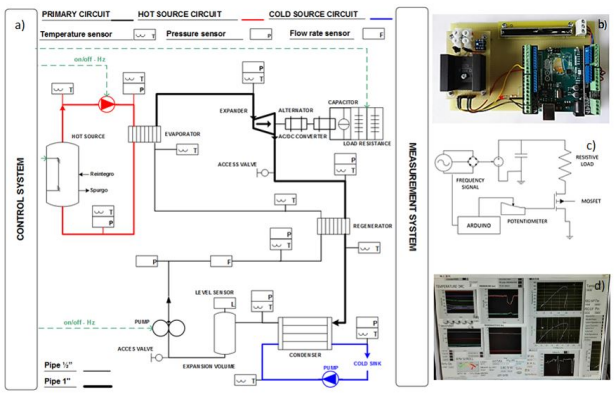
Design of an Experimental Micro-Scale ORC Plant for Residential Concentrated Solar Thermal Application

Wednesday, 25th April - 14:30 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 305

Dr. federico fagioli [1], ***Dr. Michele Salvestroni*** [1], ***Dr. Giacomo Pierucci*** [1], ***Dr. Matteo Messeri*** [1], ***Prof. Maurizio De Lucia*** [1]

1. *Università di Firenze*

ORCs power plants are the most suitable systems for low-grade thermal energy recovery and power conversion. Coupling a micro-scale ORC plant with Parabolic Trough Collectors as thermal source can satisfy the demand of a domestic user in terms of electrical and thermal power. The aim of this work is the development of an experimental micro-scale ORC plant to evaluate the application and detect the improvements perspectives. A numerical analysis has been developed with the purpose of designing the experimental test bench and predict the operation of the plant in different working conditions. Within the plant design, special attention has been reserved to sensor and instrumentation setting with the purpose of characterize each component in terms of pressure, temperature, power and energy. A software specifically developed in National Instrument Labview® environment, allowing a direct connection to the NIST REFPROP® thermodynamic properties libraries, manages the instruments. This paper carries out the development process of the ORC experimental plant, outline numerical results of the designing model, describes the test prototype and present the investigation of some experimental working condition points.



P i daq and management system.jpg

Design, Construction and Preliminary Evaluation of a Vertical Diffusion Still for Solar Thermal Assisted Desalination

Wednesday, 25th April - 14:47 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 143

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This paper presents an overview of the solar assisted desalination project, which began in Fall 2015 and culminated in the design of a pilot plant solar assisted desalination of seawater in Qatar. While seawater desalination is an energy intensive process often associated with sustainability issues and environmental impacts, this project aimed at developing a solution that minimizes environmental consequences of conventional desalination by using solar energy. Earlier experimental work on water heating showed that flat plate solar collectors that implement improved geometric patterns have potential to heat water to temperatures close to that required for desalination. To this end, a single-effect vertical distiller was developed with the detailed design focused on production and ease of maintenance. The heat collection part was designed to provide, continuously, the hot water to the distillation unit and circulation of air in the two plates was maintained by natural convection. A pilot desalination plant on was designed, fabricated and tested to demonstrate the distillation process. Parametric investigations of the design and operation conditions of the single effect vertical distillation concept was carried out. In the preliminary investigation, grey water was used to demonstrate the distillation effect. Productivity of the proposed system at different times were determined. It was found that productivity increased with an increase in the temperature of the grey water feed, the thickness of the diffusion gap between partitions, and the feeding rate of grey water. Tests on the distillate shows differences in comparison to the feed grey water. Obtained results demonstrate that solar desalination could be a viable option if auxiliary water heating is provided in order to reach the temperature ranges required for seawater desalination. The paper also discusses gain ratio, operating temperature, materials of construction, operation and maintenance of the system, and associated problems. Attempts to identify areas of development and improvements are also presented with specific reference to the proposed solar assisted seawater desalination.

Acknowledgements

This research was made possible by a NPRP award NPRP 5-161-2-053 from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the authors.

Multi-focusing Analysis and Impact of PV-Solar Resource in Groundwater Pumping Agriculture Applications

Wednesday, 25th April - 15:04 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 70

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Nowadays, most developed countries are promoting policies and initiatives focused on the integration of renewable energy resources into different sector, such as industrial, agricultural or residential sectors. Specifically, the energy model currently applied on the agriculture sector for pumping groundwater purposes needs important changes to decrease fossil fuel dependence, emissions and a giving more sustainable solution. In this way, solar resource emerges as a suitable substitute for diesel equipment, mainly in Mediterranean countries where the annual solar irradiation presents high averaged values. Under this framework, it should be desirable to have an extensive view of the risks regarding sustainability in the agriculture sector for pumping irrigation proposals, not only from the economic and energy point of view, but also considering other relevant aspects, such as water efficiency, environmental and cooperative possibilities of the sector. Actually, a more general view of the agents can provide more efficient solutions by considering most parameters that have influence on the groundwater pumping problem: aquifers, farmers, rural areas, energy equipment... This paper describes a multi-focusing approach to evaluate the impact of PV solar resource integration into agriculture irrigation purposes from an extensive analysis. A relevant amount of variables are thus considered, including relations and dependence among them to design a more accurate and efficient implementation an integration of PV solar energy in the pumping agriculture. Preliminary results corresponding to the proposed multivariable and multidimensional analysis are also included in the paper taking into account water requirements, energy needs, environmental impact and socioeconomic conditions. An aquifer located in the South-East of Spain has been considered as case study. Relevant information about the aquifer, crops and current agricultural situation is also included in the paper.

Carbon emissions reductions in cities through large scale PV deployment

Wednesday, 25th April - 15:21 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 291

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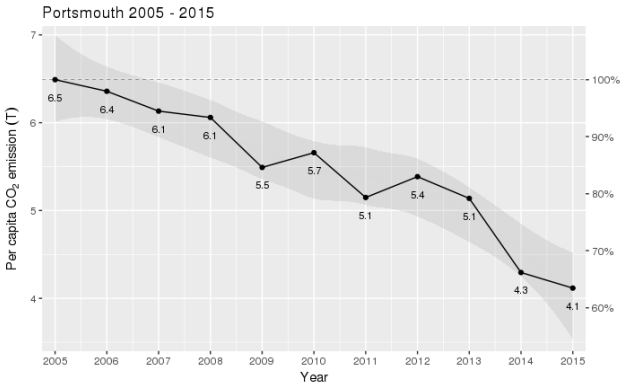
Driven by the UK national target of reducing carbon emissions by 80% by 2050, many UK cities including London, Southampton, Birmingham, and Liverpool have published their own emission reduction targets. Realising these targets is through the development of low carbon strategies that can be achieved within the city border. Such strategies will require local authorities to conduct appropriate assessments of energy resources whilst addressing the challenges faced with the densely populated urban areas. In this work, the city of Portsmouth in the South of the UK was selected as a case study due to its high population density and appropriate building stock characteristics. Figure 1 shows the CO2 emissions of Portsmouth for the period 2005 to 2015, which showed a 37% drop in emissions from 6.5 tonnes to 4.1 tonnes per person.

However, as an island city, Portsmouth is faced with geographic limitations, causing its building stock to evolve with significant structure diversity during urban development. Therefore, the deployment of renewable energy systems, such as rooftop solar photovoltaics (PV), would face additional challenges caused by irregular building structure and inter building shading within a high dense urban environment.

To provide a clear understanding of the potential of building integrated and attached solar PV, a city-wide building model was developed to automatically identify suitable areas for the installation of solar PV. The model takes into account both engineering and economic assessment for each individual buildings in the city, providing more realistic estimates of power production in the context of densely populated areas. The model was applied to all buildings in Portsmouth (number > 111,000) and considers different scenarios based on roof areas, costs, and PV system capacity. The result from the central scenario indicates that 18,654 buildings (17%) in Portsmouth are suitable for rooftop PV. If the model estimated areas were fully utilised this could provide the city with around 54 MWp installed capacity. These results as well as the implication to cost and carbon emissions are also discussed in the paper.



Portsmouth percapitaemission.png

Thiadiazolosubporphyrazines as efficient electron acceptors in organic photovoltaic cells

Wednesday, 25th April - 15:38 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 77

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We have synthesized a series of small molecules-subporphyrinoids demonstrating high potential as alternative to fullerene for use in the organic solar cells. Chemical functionalization of subphthalocyanine molecule through adding halogens on the periphery is an effective strategy to obtain non-fullerene acceptors for the molecular or hybrid junctions [1]. Alternatively, we have modified the subporpyrazine core by annulation of electron-deficient 1,2,5-thiadiazole rings, so that the lightweight, air-stable and optically active molecules with strongly electron accepting properties are obtained [2]. Their chemical structures and the positions of molecular orbitals were elucidated both theoretically and experimentally [3].

The prototype thin-film photovoltaic cells with a fully subporphyrinoid planar heterojunction were fabricated, in which unsubstituted subphthalocyanine serves as a donor, and acceptor was its low-symmetry analog, 1,2,5-thiadiazole subporphyrazine [2,3]. Thickness and material of the interfacial layers were carefully optimized to enhance the charge transport in the device. J-V characteristics of thus made devices in the dark and under 1 sun illumination were measured in laboratory conditions; the EQE spectra were compared with the absorption spectra of the photoabsorber pairs in the range of 380-1000 nm.

It was found that the output parameters of the prototype cells vary largely with the chemical structure of subporphyrazine molecule and with the nature of adjacent cathode underlayer, which is a critical issue for the electron extraction. While the open circuit voltage lies in the range of 0.7-1.2 V, the short circuit current differs by orders of magnitude. The best performing devices employ a low symmetry subporphyrazine, their power conversion efficiency exceeds that of equivalent cells with a fullerene acceptor, considering that narrower spectral domain is utilized. The next steps to enhance the photon capturing capability and to increase the stability of the obtained small molecule based devices are discussed.

Acknowledgement is expressed to Russian Science Foundation (#17-13-01522).

[1] Cnops K., Zango G., Genoe J., Heremans P., Martinez-Diaz M.V., Torres T., Cheyns D. J.Am.Chem.Soc. 137 (2015) 8991.

[2] Hamdoush M., Skvortsov I.A., Mikhailov M.S., Pakhomov G.L., Stuzhin P.A., J. Fluorine Chem. 204 (2017) 31.

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Solar e-cooking: Solar Home System Integrated Clean Cooking Using Solar PV

Wednesday, 25th April - 15:55 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 262

Dr. Simon Bachelor [1], Mr. Arifur Rahman Talukder [2], Mr. Md. Raihan Uddin [3], Mr. Sandip Kumar Mondal [3], Ms. Shemim Islam [3], Mr. Rezwanul Karim Redoy [3], Dr. Rebecca Hanlin [4], Prof. Mohammad Khan [3]

1. *Gamos Limited,* ***2.*** *Practical Action,* ***3.*** *United International University,* ***4.*** *ACTS*

In this paper we propose to use solar PV for clean cooking. With an efficiency of 18-19% for the commercially available PV panels, using solar PV as for cooking (heating) attracts immediate criticism that it is a highly inefficient way of cooking. Although this argument cannot be ignored, solar PV based cooking has its own merits, both technological and economic, if designed and integrated with PV systems properly. With the falling price of the solar PV, it looks more and more attractive to use solar PV as an energy source for clean cooking. To keep the cooking power low, it is important to keep the heat loss at a minimum level. We have shown that insulation of the stove (Fig.1) and the pans are important to keep the energy consumption low for cooking. We have also proposed insulated resting place for the pans after taking off from the stove (Fig.2) so that slow cooking may still continue. If the heat loss is contained properly, it is possible to cook with a low power source less than 500W. A slogan is adopted – 'Heat does not cook, it is the temperature that cooks' to attract attention to the fact that retaining temperature inside the cooker and the cooking pan is important for energy efficient cooking. A prototype solar e-cooker was designed, fabricated and tested by cooking different foods. An efficiency of 87% has been achieved in the prototype cooker and the water boiling results are presented in Table 1. Experimental results are presented to show that cooking is possible using much less energy than we usually think. A cost analysis is also presented to show that such a cooker can be cost effective, costing less than USD 10 per month, in off-grid areas if connected to a properly designed Solar Home System.

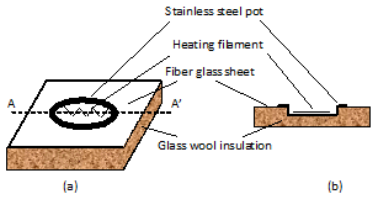

Fig.1. (a) Schematic diagram of an e-cooker, (b) crosssectional view at AA'.

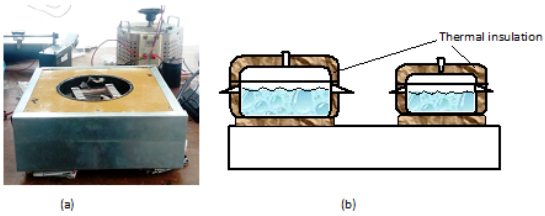

Fig.2. (a) Photograph of the solar e-cooker and (b) the insulated resting place for the pans after taking off from the stove

Amount of Water: 2 Litre, Pan Weight: 0.440 Kg Power Supplied: 297 watt, Estimated efficiency =86.5%	
Time in minute	Temperature inDegree Celsius
0.00	26
10.00	43
20.00	62
30.00	82
35.00	92
40.00	100

Table 1. Water boiling experiment data

Figs table.png

Energy Assessment for a 300-MW wind farm in mountainous area

Wednesday, 25th April - 14:30 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 297

Dr. Matteo Ranaboldo [1], ***Mr. Santi Vila*** [1], ***Mr. José Vidal*** [1], ***Ms. Claudia Puyal*** [1], ***Ms. Jesica Piñon*** [1]

1. *UL Renewables*

Energy assessment studies in a pre-construction phase are a key step in the development of a wind farm. In recent years, the growth of big project located in always more complex environments makes this energy assessment becoming a challenge. In this context, North-Eastern Brazil is a region where a very good wind resource is available at several sites, with mean wind speeds above 9 m/s at 80-100 m. Many of the most promising areas are located in complex terrain, i.e. mountains with high steepness or at the top of elevated plateaux.
In this study, the energy assessment of a wind project located in one of such areas in North-Eastern Brazil is presented (Figure 1). The project consists of 131 turbines totaling 303 MW of installed power.

For the energy assessment, a total of 18 meteorological masts were installed over an area of around 20 x 20 km (Figure 2).

Mast data with a recording period between 6 months and 6 years were validated and long-term adjusted using a re-analysis dataset. A wind map of the area was generated using numerical wind flow model, in this case the Sitewind system: a method developed by AWS Truepower which combines meso-scale and micro-scale scale modelling. The resulting wind resource map, which is adjusted to mast measurements, gives information about mean wind speeds, wind rose and sectorial wind speed distribution on a grid with 50 m spacing (Figure 2).
This map is used as input to calculate the production of the wind project. In order to obtain the net production losses were also assessed, such as wakes, availability, electrical, turbine performance, environmental and curtailment losses. The total energy uncertainty of this assessment was finally estimated according to industry standards.
The pre-construction production estimation of 34 turbines (shown as circles in Figure 2) was compared with the one obtained using production data after 1 year of operation, which has a much lower uncertainty. The comparison shows a very good agreement between pre-construction and operational assessments (Table 1), thus confirming the high reliability of the energy assessment.

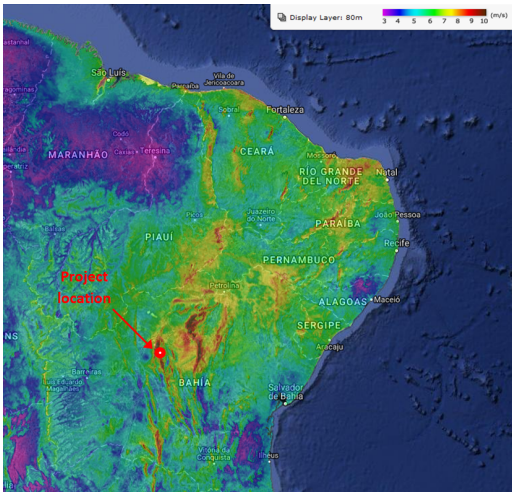

Figure1.png

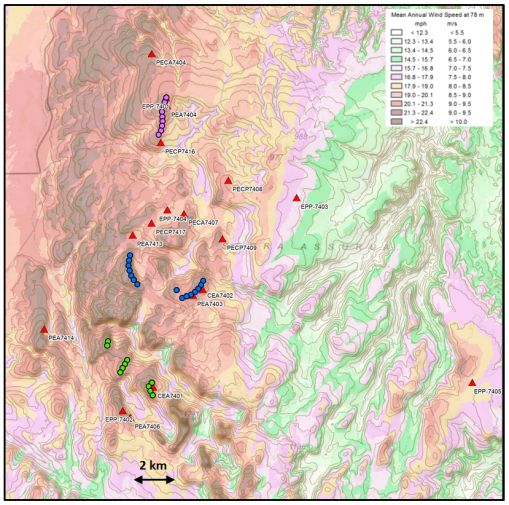

Figure2.png

Study	Net Energy Production (GWh/yr)	Net Capacity Factor (%)	Uncertainty	
			(GWh/yr)	(%)
Operational	340.2	57.1	10.7	3.1
Preconstruction	342.5	57.5	17.8	5.2

Table1.png

Influence of the open jet inlet on the wind turbines experiments

Wednesday, 25th April - 14:47 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 78

Mr. Victor Mendoza [1], ***Dr. Anders Goude*** [1]

1. *Uppsala University*

Numerical and experimental results are essential tools in order to understand the resulting flow pattern of operating wind turbines, and therefore, in the design for maximum loads on the components and the spacing arrangement in wind farms.

Due to the complexity of the flow phenomena involved in the aerodynamics of both horizontal and vertical axis wind turbines, several and well known experimental activities have been carried out on open sites and wind tunnel facilities for identifying the relevant parameters of the flow involved and the performance of the tested devices.

For the studies in wind tunnel facilities, for avoiding the blockage effect of a confined tunnel, it is a common practice to have an incoming flow from an open jet at the inlet. However, an open jet itself is characterized by a flow with an abrupt expansion and recirculation zones (in the regions close to the corners of the test chamber), which can considerably influence the obtained results from the turbine.

In the present work, simulated blade loads and the resulting wake from an operating vertical axis wind turbine are studied using an actuator line model. The Open Jet Facility at Delft TU experimental work (G.Tescione et al. - 2014) is used as a reference case, together with a simulation where the open jet is replaced by a uniform flow over the whole section.

The obtained results show a difference in the wake structure (size, shape and location) and blade forces when replacing the open jet. Figures 1 and 2 depict that the lateral and vertical wake expansion is reduced by the incoming uniform flow. Figure 3 reveals that the wake breaks earlier in the case with an open jet. Additionally, there is a dissipation of energy due to the expansion of the flow and the recirculation zones, and therefore, a reduction on the forces acting on the blades.

Generally, there is a considerable difference on the obtained results between using an open jet at the inlet of the test chamber and a uniform flow.

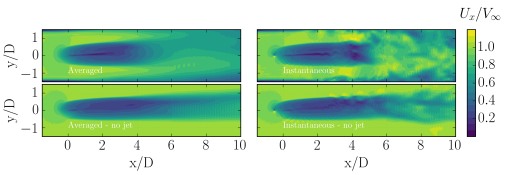

Figure 1.png

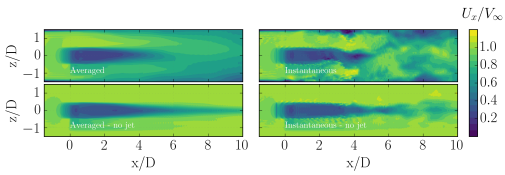

Figure 2.png

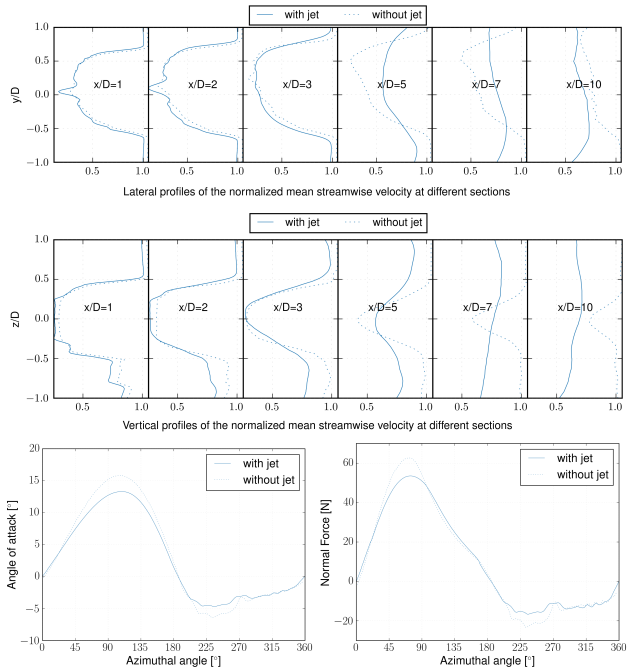
with jet
without jet
y/D
x/D=1
x/D=2
x/D=3
x/D=5
x/D=7
x/D=10
Lateral profiles of the normalized mean streamwise velocity at different sections
z/D
Vertical profiles of the normalized mean streamwise velocity at different sections
Angle of attack [°]
Azimuthal angle [°]
Normal Force [N]

Figure3.png

A Smart renewable energy system for Campania Region (IT)– Strategies and actions towards the achievements of the 2030 European targets.

Wednesday, 25th April - 15:04 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 99

Dr. salvatore fabozzi [1], ***Dr. Giuseppina De Luca*** [1], ***Prof. Nicola Massarotti*** [1], ***Prof. Laura Vanoli*** [2]

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Campania Region is one of the larger consumer of thermal and electric energy in Italy. Therefore, the identification/verification of a strategy/Regional Plan to supply the energy demand required is an important step through which Italy can fulfil the objectives set up by the European Commission. Campania region reflects the current state of Italy: the presence of a high potential from a renewable energy source which, however, is not completely used. Campania can count on wind, geothermal, solar radiation as well as on reserves of water that make the territory one of the regions with the highest potential for renewable energy.

The work starts from the lack of adequate controls to support the Region in the challenge of transforming the present energy system to a smart renewable energy system. In particular, in order to predict the results of actions that could be implemented, the paper focuses on the analysis of current regional energy balance (base-scenario) and proposes new RES and energy efficiency actions (EEA) towards the achievements of the 2030 European targets. The identification of the most appropriate combination of RES/EEA is based on six alternative development scenarios for the Region. The scenarios are explored taking into account the available renewable sources: geothermal, solar and wind.

The whole regional energy system is analyzed by the EnergyPLAN software to evaluate streams combination and potential synergies between the different sectors and technologies. The system behaviour is analyzed considering different time bases: hourly, weekly and yearly. The hourly energy production of already installed plants is obtained from measured data; for new systems/technology proposed, a detailed model is used to simulate the performance and calculate hourly production in TRNSYS environment. The EnergyPLAN outputs include the aggregated yearly production and demands of all modelled energy conversion systems, as well as hourly values useful to identify the measures to make Campania Region fulfil the 2030 European target. Finally, an economic analysis is performed to identify the most cost-effective scenario. The outcomes for the work have the potential to support local and national administrations to elaborate more efficient plans for heating and cooling supply.

Economically-Limited Onshore Wind Capacity and Production in European Nations

Wednesday, 25th April - 15:21 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 274

Mr. David Severin Ryberg [1], ***Ms. Dilara Caglayan*** [1], ***Mr. Jochen Linßen*** [1], ***Dr. Martin Robinius*** [1], ***Dr. Detlef Stolten*** [1]

1. *Forschungszentrum Jülich*

In the context of meeting CO_2 emission reduction targets to fulfill climate action plans, expansion of renewable energy sources into future energy systems represents a common research theme. Onshore wind turbines currently hold one of the highest shares in renewable electricity generation worldwide, with the second highest growth over the last 25 years, which will surely continue in the future. It is well known that electricity generation from wind turbines is characterized by spatially-sensitive intermittency, and furthermore that the placement of turbines is strongly influenced by the sociotechnical criteria; such as proximity to settlements, terrain suitability, and conservation efforts. Nevertheless, wind scenario studies commonly do not account for all of these concerns in detail; typically over simplifying the impact of sociotechnical criteria on the final distribution of a desired capacity across a study region. To improve upon this deficiency, the work described here incorporates contemporary techniques for the simulation of hourly wind turbine performance at large spatial scales in coordination with land eligibility concerns.

Using the European continent as the study region, the applied method proceeds as follows. First, every 1 km^2 location in Europe is simulated at the hourly level considering multiple turbine models and 36 weather years (Figure 1). A previous land eligibility result is used along with a turbine placement algorithm to identify the maximal number of turbines which can be placed in the available areas with a minimal distance of 850 meters enforced between turbines. The placements are then matched to their expected FLH, and a cost model is used to determine the best turbine model and the associated levelized cost of electricity (LCOE) for each placement following the approach of Robinius et. al. Ordering by cheapest LCOE, the average FLH and LCOE of each country is determined as a function of installed capacity (sample trends displayed in Figure 2). By choosing an economically-constrained average LCOE of 11, 9, 7, and 5 Euro-ct/kWh, it finally becomes possible to determine the economically-limited capacity and production within each of the evaluated countries, shown in Table 1.

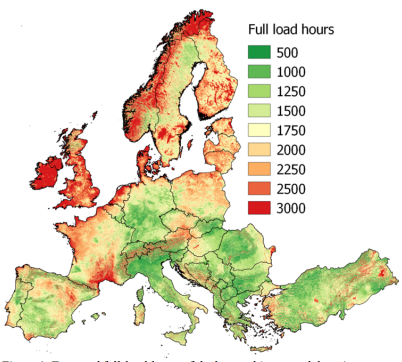


Figure 1: Expected full-load-hours of the best turbine at each location as a result of 36 simulation years

Fig 1.png

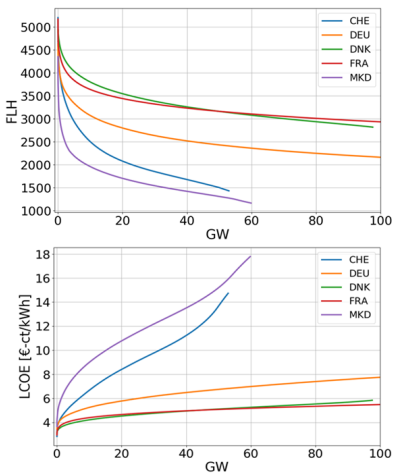


Figure 2: Example trends for average full-load-hours (FLH) and levelized cost of electricity (LCOE) as a function of installed capacity. Placement selection is performed for constitute each capacity according to cheapest LCOE.

Fig 2.png

Region	Turbines	Capacity [GW]					Production [TWh/a]				
	LE	LE	11ct	9ct	7ct	5ct	LE	11ct	9ct	7ct	5ct
Europe	**2,903,761**	**10,205**	**9,077**	**7,252**	**3,312**	**966**	**19,807**	**18,312**	**15,729**	**8,603**	**3,235**
France	343,439	1,185	1,185	1,185	572	42.9	2,401	2,401	2,401	1,346	138
Sweden	325,020	1,121	1,121	824	279	36.6	2,161	2,161	1,714	705	118
Spain	334,084	1,152	1,152	834	245	17.5	2,045	2,045	1,602	574	56.5
Finland	220,279	760	760	710	195	14.1	1,561	1,561	1,488	500	45.2
Norway	159,297	550	550	550	478	262	1,399	1,399	1,399	1,281	866
United Kingdom	128,679	444	444	444	444	262	1,278	1,278	1,278	1,278	850
Poland	152,584	526	526	526	142	1.0	1,056	1,056	1,056	329	3.10
Italy	168,653	582	400	233	64.0	4.4	915	651	436	148	14.1
Germany	138,002	476	400	201	60.8	6.98	760	663	384	143	22.4
Romania	152,584	526	255	74.7	9.5	1.0	757	410	142	23.1	3.11
Ireland	56,804	196	196	196	196	196	732	732	732	732	732
Lithuania	53,661	185	185	185	86.7	1.0	399	399	399	205	2.93
Portugal	63,170	218	195	94.4	17.5	1.0	377	340	191	42.2	3.19
Greece	69,866	241	180	109	45.8	8.0	373	299	209	108	25.8
Latvia	48,537	167	167	167	44.8	1.0	346	346	346	108	3.13
Serbia	67,996	235	96	30.6	7.43	1.0	338	160	61.7	18.2	3.07
Hungary	5,979	210	155	63.9	1.37	1.0	324	257	121	3.17	2.34
Bosnia and Herzegovina	51,456	178	152	107	55.8	13.2	314	272	218	135	42.7
Bulgaria	62,215	215	76.7	18.1	1.63	1.0	300	125	34.7	3.88	2.46
Austria	41,222	141	131	111	68.5	13.5	278	248	231	166	43.9
Denmark	28,305	98	98	98.0	98.0	43.5	275	275	275	275	140
Czech Republic	42,905	148	148	115	20.6	1.0	274	274	225	48	2.75
Estonia	36,169	123	123	123	46.3	2.25	263	263	263	114	7.21
Croatia	31,484	109	97	48.8	15.6	1.98	184	166	96.7	37.2	6.38
Netherlands	15,559	54	54	54.0	54.0	17.3	132	132	132	132	55.8
Slovakia	21,153	73	48.9	29.3	3.95	1.0	113	83.0	56.6	9.33	2.64
Montenegro	13,525	47	44.4	36.1	19.9	3.8	89.3	80.1	72.1	47.1	12.2
Albania	16,167	55	38.4	24.1	11.4	2.4	83.9	64.4	46.6	27.0	7.74
Macedonia	17,548	61	21.5	10.1	3.18	1.0	83.1	36.0	19.7	7.44	2.80
Switzerland	15,508	54	38.6	24.2	11.6	2.97	81.8	65.5	47.6	27.9	9.62
Slovenia	9,669	33	12.0	5.22	1.67	1.0	46.7	20.6	10.6	4.10	2.62
Kosovo	7,456	26	11.7	5.78	2.43	1.0	36.8	20.1	11.7	5.88	2.84
Belgium	4,196	14	14	13.7	7.74	1.0	27.9	27.9	27.6	18.0	2.82
Luxembourg	590	2.0	1.0	1.0	1.0	1.0	2.94	1.65	1.65	1.65	1.65

Table 1: The maximal onshore wind capacity and annual electricity production of European countries subject to sociotechnical and economic constraints. Columns labeled Land eligibility (LE) report sums which are only constrained by the locations that wind turbines can be placed according to the previous LE analysis [2]. The other columns each correspond to national capacity and production sums such that the average LCOE of that country is equal-to or below the indicated price per kWh. Results assume a 3.6 MW turbine with 90 meter hub height and 120 meter rotor diameter costs 1000 Euro/kW with an additional 17% for connection and administrative costs

Tab 1.png

Towards more resilient electrical networks in urban areas

Wednesday, 25th April - 15:38 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 240

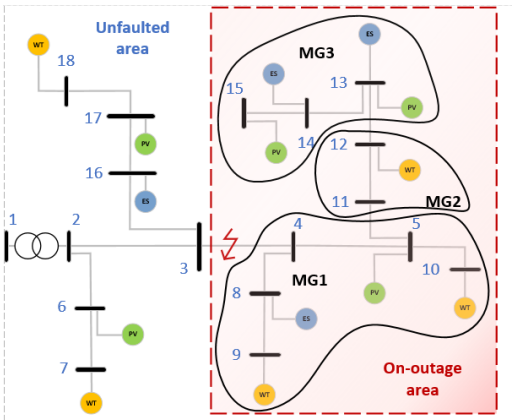
Ms. Anna Palau Mayo [1], ***Dr. Mikel De-Prada-Gil*** [1], ***Dr. Jose Luís Dominguez*** [1]

1. *Catalonia Institute for Energy Research (IREC)*

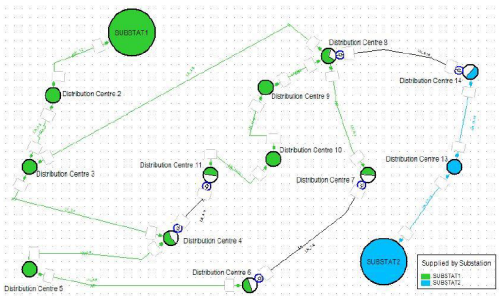
The requirement of system decarbonisation fixed by the EU 2050 plan is leading to an increased establishment of renewable energy sources. Additionally, the disruption of power electronics and ICT technologies has played a decisive role towards a novel distribution electric grid allowing new monitoring, operation and control. In parallel to the energetic transition, an increasing occurrence of extreme weather events and a reinforced concern on climate change leads to the concept of resilience, which is the capacity to adapt and recover from disruptive events in a coordinated procedure.

The present study aims at analysing the effects of integrating renewable distributed generation at a distribution level in order to increase distribution grid resilience as well as to ensure and secure power supply to the system. At a city level, if an outage occurs in the main grid, and there are no redundancies in the system, several customers can be left unsupplied. Therefore, in the present study it is also interesting to explore future Distributed Energy Resources (DER) penetration scenarios with current electrical models for investigating new electrical concepts such as microgrid (MG) clusterization.

With novel controllable technologies and during a failure event, the on-outaged areas are able to disconnect from the main grid, creating isolated MGs which can work autonomously. MGs operate independently from each other and due to the variability of energy inputs and the lack of current technological adaptation, such power islands are prone to instabilities. [JLD1] Sudden unbalances between generation and consumption lead to the idea of clustering several MGs in order to increase the system stability. Nowadays, MG clusterization is still at an early research state, however, with the increasing concern on decarbonisation, the scenario of decentralised and distributed power systems is gaining force.



Automatic reconfiguration scheme after a system failure.png



Mv distribution network with digsilent.png

An offshore wind farm energy injection mastering using aerodynamic and kinetic control strategies

Wednesday, 25th April - 15:55 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 265

Dr. Djamel Ikni [1], Dr. Ahmed Ousmane BAGRE [2], Dr. Mamadou Baïlo Camara [1], Prof. Brayima Dakyo [1]

1. *university of Le Havre,* ***2.*** *International institute for water and environmental engineering*

The injection of wind farm production into a grid, needs optimal strategies for energy transfer management. Usually, the power produced by the wind farms does not fulfil all the grid code requirements. The main problem is generally based on the way to reduce the impacts of power production fluctuations on the grid voltage and its frequency. To solve this problem, some authors suggest the use of an interface such as energy storage devices in order to compensate the wind power fluctuations.

In fact, the storage devices installed between the wind farm and the grid can improve the power quality in terms of stability but in other hand the size and the cost of the system can be increased. In this paper energy quality improvement from a storageless offshore wind farm and connected to the grid is discussed. Two solutions have been proposed in case the power quality produced by the wind farm is out of the grid code requirements.

To illustrate the concept, a model comprising 60 Permanent Magnet Synchronous Generators (PMSG) with rated power of 5MW for each one and a back to back converter using field-oriented control method has been modelized and simulated.

The model of wind developed in this study is based on a distribution approach for 10 sectors.

Design and Development of a Novel Centrifuge Ablative Pyrolysis Approach for Biomass Conversion to Bio-oil and Bio-char

Wednesday, 25th April - 16:40 - Bioenergy and biomass conversion technologies - Auditorium - Oral - Abstract ID: 377

Dr. Murlidhar Gupta [1]***, Dr. Andrew Mcfarlan*** [1]***, Dr. Fernando Preto*** [1]***, Mr. Leslie Nguyen*** [1]

1. *CanmetENERGY, Natural Resources Canada*

Pyrolysis has evolved as key pre-treatment step to produce renewable fuels and chemicals from agricultural and forestry residues. In the past few years, there have been different directions in the development of pyrolysis reactors. For example, in vortex and cyclone approaches, biomass particles are suspended in a flow of high supersonic velocities to ensure enough centrifugal forces for pressing the particles against the heated reactor surface. Although simple in design, the main problem with these reactors is their requirement of large volumes of carrier gases relative to biomass feed, which necessitates cumbersome gas separation, resulting in thermodynamic penalties and higher capital equipment costs. In ablative systems, with little or no carrier gases, the key challenge relates to using an appropriate mechanism to continuously apply force on biomass particles during pyrolysis. As an alternative approach recently, thermo-mechanical rotors at very high rpm have been used to create the required centrifugal forces for pressing the biomass particles against the heated walls of a concentric shell. In the current approach, a modular centrifuge pyrolysis system has been designed using Biot and Thiele numbers as key constraints for characterizing ablative regimes. Reactor design is based on heat transfer coefficients as high as 300 $W.m^{-2}.K^{-1}$. Unlike other centrifuge pyrolysis reactors, the novel rotor mechanism incorporated in this reactor system facilitates constant centrifugal force as well continuous axial propagation of biomass feeds. The 10 kg/hr thermo-mechanical pyrolysis system has been successfully commissioned generating 0.8 kG force using hardwood sawdust. Properties of bio-oil and bio-char produced in this new reactor are comparable to products from other fast pyrolysis processes. In addition to its compact and modular design suitable for mobile pyrolysis units, it can be operated in variable regimes of pyrolysis *e.g.* slow to fast modes, allowing product distribution to be adjusted.

Use of Acidic Ion-Exchange Resins in the Transformation of Biomass into Biofuels

Wednesday, 25th April - 16:57 - Bioenergy and biomass conversion technologies - Auditorium - Oral - Abstract ID: 249

Prof. Eliana Ramírez [1], Prof. Roger Bringue [1], Prof. Carles Fité [1], Prof. Montserrat Iborra [1], Prof. Javier Tejero [1], Prof. FIDEL CUNILL [1]

1. *University of Barcelona*

Introduction

Lignocellulose (65-85% of biomass) is an inexpensive non edible biomass that can be an excellent source of for biofuels and chemicals. These new fuels are called second generation biofuels or advanced biofuels. Fig. 1 shows the main routes to produce biofuels from lignocellulose. In this reaction pathway, the formation of several platform (building block) chemicals such as furfural, 5-hydroxymethylfurfural (5-HMF) and levulinic acid (LA) is highlighted. However, the release of sugar from lignocellulose and its transformation into biofuels is uneconomic compared with to first generation biofuels obtained from edible sources, since platform molecules are highly oxygenated compounds and their conversion into liquid fuels requires a partial oxygen removal. The present work shows the potential of acidic ion-exchange resins as a promising low-cost catalyst to be used in many reactions from biomass to biofuels with the same catalytic activity than other acid solids but under milder conditions (<190 ºC).

Method

Experiments have been carried out in a batch stirred reactor at 50-150ºC and under pressure using several gel type and macroreticular acidic ion-exchange resins. Liquid samples were taken hourly and analyzed by means of GC and HPLC.

Results and conclusions

Table 1 lists some of our works on certain reactions shown in Fig. 1. Using ion exchange resins is a good option to produce 5-HMF, levulinic acid, levulinic esters and C_{12}^{+} oxygenated intermediate molecules under mild conditions. Work on optimization of the reaction conditions using ion-exchange resins as catalysts has recently started. Results are promising. For example, the esterification reaction of levulinic acid with 1-butanol proceeds with practically total conversion and selectivity to the corresponding ester on Dowex 50Wx2 at temperatures as low as 80ºC. Working at low temperatures avoids the formation of undesired byproducts like humins.

To tailor the best resin, the study between the resin morphological/structural properties and the catalytic activity relation is required. Furthermore, tests on catalyst reusability are of utmost importance for process economics.

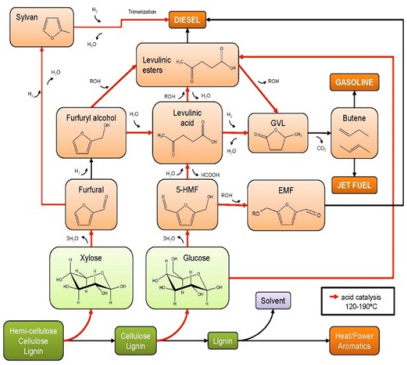


Figure 1. Use of acidic ion-exchange resins for obtaining biofuels from lignocellulosic biomass

Figure 1.jpg

Table 1. Performed studies on biomass to biofuels steps using acidic ion-exchange resins

REACTION	SOLVENT	RESIN	T (ºC)	t (MIN)	CONV (%)	SELECT (%)	YIELD (%)	REUSE
Fructose dehydration to 5-HMF	Dioxane	Dowex 50wx4-100 (G, 4% DVB)	90	120	N/A	N/A	72.4	N/A
Etherification of furfuryl alcohol with 1-butanol to BL	1-butanol	Amberlyst 39 (M, 8% DVB)	100	360	100	67	67	N/A
Levulinic acid production from fructose	Dioxane	Dowex 50wx2-100 (G, 2% DVB)	100	480	N/A	N/A	34	N/A
Esterification of levulinic acid with 1-butanol	1-butanol	Dowex 50wx2 (G, 2% DVB)	80	480	93.6	99.9	93.5	N/A
Esterification of levulinic acid with 1-butanol with water removal	1-butanol	Dowex 50wx2 (G, 2% DVB)	128	180	100	97.6	97.6	N/A
Butyl levulinate production from reaction of fructose with 1-butanol	1-butanol/H_2O	Dowex 50wx2 (G, 2% DVB)	120	480	99.9	42.4	42	3 cycles
Butyl levulinate production from reaction of fructose with 1-butanol	1-butanol/H_2O	Purolite CT-482 (M, low % DVB)	150	480	99.9	52.6	53	N/A
Butyl levulinate production from reaction of HMF with 1-butanol	1-butanol/H_2O	Dowex 50wx2 (G, 2% DVB)	120	300	95.5	42.2	40.3	N/A
Hydroxyalkylation/alkylation of Sylvan with butanal		Dowex 50wx2 (G, 2% DVB)	50	360	>95	>99	94	3 cycles

M, macroreticular or macroporous resin
G, gel-type or microporous resin
DVB, divinyl benzene content

Table 1.jpg

Production of liquid biofuels by microwave-assisted hydrothermal liquefaction of pine and spruce biomass

Wednesday, 25th April - 17:14 - Bioenergy and biomass conversion technologies - Auditorium - Oral - Abstract ID: 84

Dr. Javier Remón [1]***, Mr. James Randall*** [1]***, Dr. Vitaliy L. Budarin*** [1]***, Prof. James H. Clark*** [1]

1. *University of York*

1. Introduction

The increase in the worldwide energy demand along with declining resources have led researches to seek alternative technologies, materials and more sustainable strategies to produce energy, fuels and chemicals. In this context, hydrothermal Liquefaction (HTL) of biomass represents a promising and green alternative for biofuel production. In addition, as water is highly effective in microwave energy absorption, the combination of hydrothermal conditions together with microwave assisted heating allows a liquid product with appropriate fuel properties to be produced in a greener and more energetically efficient manner.

2. Method

This work addresses the valorisation of pine and spruce biomass pellets by means of microwave-assisted HTL using a co-precipitated Ni-Co/Al-Mg catalyst. In particular, the effects of the temperature (150-250 ºC), pressure (50-120 bar), reaction time (0-2 h) and catalyst/biomass ratio (0-0.25 g/g) were experimentally investigated on the products distribution and the most important physicochemical properties of the liquids produced. The experiments were planned according to a full factorial design of experiments and analysed by means of an ANOVA test.

3. Results and discussion

The statistical analysis of the results revealed that the operating variables had a significant influence on the process; the yield of solid, bio-oil and gas varying by 22-87%, 0-29% and 7-67%, respectively. The proportions of C, H and O in the bio-oil shifted by 2-70 wt.%, 4-11 wt.% and 25-87 wt.%, respectively, which varied its Higher Heating Value (HHV) between 4 and 28 MJ/kg. The GC-MS analysis of the bio-oil showed that it consisted of a complex mixture of esters (0–30%), aldehydes (4–69%), ketones (0-35%), alcohols (0–14), phenols (0–83), acids (0–28), cyclic compounds (0–38), acetates (0–10), ethers (0–27%) and furans (0–20%). The optimisation of the process revealed that it is possible to transform up to 27% of the biomass into a rich phenolic (47%) bio-oil, having a relatively high HHV (20 MJ/Kg) when a temperature of 250 ºC, a pressure of 80 bar and 0.03 g catalyst/g biomass are used for 2h. These promising results suggest that this process might represent a step-change in the production of liquid bio-fuels and platform chemicals from biomass.

Evaluation of Energy Crop Hybrid Poplar for Non-energy Application

Wednesday, 25th April - 17:31 - Bioenergy and biomass conversion technologies - Auditorium - Oral - Abstract ID: 156

Prof. Siqun Wang [1], ***Dr. Yurong Wang*** [2], ***Ms. Xiaoyu Wang*** [1], ***Ms. Hang Chen*** [1], ***Prof. Tim Rials*** [1], ***Prof. Nicole Labbé*** [1], ***Prof. Art Ragauskas*** [1]

1. *University of Tennessee,* ***2.*** *Chinese Academy of Forestry*

Poplar trees are widely planted in subtropical and temperate regions and one of the most widespread hardwood species in North America. In general, the woody biomass currently available is not able to meet the dramatically increasing demand. Poplar trees, including their hybrids, have been considered as an alternative woody source and a means to meet the increasing demand for wood products due to their characteristics of fast growth and ease of reproduction. Hybrid poplars are important components of current energy portfolios because they produce significant amount of biomass. Furthermore, as a natural and renewable material, poplar wood has multiple purposes and can be used for pulp and paper, furniture, wood-based composites, construction and even nano materials. As an energy crop, the survival, growth rate, disease resistance, chemical composition of poplar and its hybrids are well studied. Impact of hybrid poplar on biomass conversion is also studied. On the other hand, little work has been carried out on the properties of poplar wood and influence on nano fiber separation, which remain to be assessed for non-energy application. In this presentation, we will first report the growth rate of Populus deltoides and two of its hybrids, to observe their wood anatomy, to determine the micromechanical properties of cell walls, and then to compare the differences of growth traits and wood properties of the cell walls among the three poplar clones in their early developmental stage. Then we will report relationship between species and energy consumption during the production of cellulose nanofibers. This study compared energy consumption of hybrid poplar with switchgrass, yellow poplar, and pine under the same cellulose nanofiber manufacturing process.

The COSIN project: synthetic natural gas production from biogas in a waste water treatment plant in Barcelona

Wednesday, 25th April - 17:48 - Bioenergy and biomass conversion technologies - Auditorium - Oral - Abstract ID: 92

Dr. Jordi Guilera [1], ***Dr. Teresa Andreu*** [1], ***Ms. Adriana Romero*** [2], ***Dr. Nuria Basset*** [2], ***Mr. Antoni Julia*** [3], ***Mr. Ignasi Mallol*** [3]

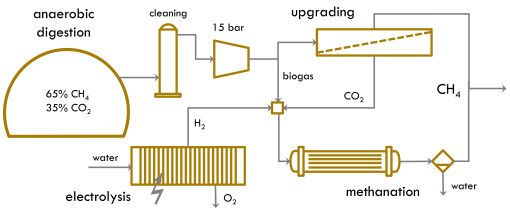
1. *Catalonia Institute for Energy Research (IREC),* ***2.*** *Cetaqua,* ***3.*** *Gas Natural Fenosa*

The CoSin project is an industrial action aiming to demonstrate the technical economic viability of synthetic natural gas production at a sewage treatment plant in Barcelona area. In contrast with current fossil natural gas, the gas obtained is totally renewable when integrated to green electricity.

The selected sewage plant (EDAR Riu Sec, Sabadell) has now in operation two anaerobic digesters to treat the primary and secondary slurry, only for environmental purposes. After anaerobic digestion, the obtained biogas is now used to maintain the digesters at the mesophilic range. In this project, two routes to upgrade this biogas to synthetic natural gas, with the required quality to be injected to the local gas grid, are evaluated.
The first technology to be validated is biogas upgrading with membranes. The installed capacity is 50 Nm^3/h. Prior to upgrading, the biogas will be dried, cleaned and compressed. A renewable biomethane stream will be obtained and it could be injected to the gas grid. The carbon dioxide stream will then be used in the second route, a power-to-gas plant where the catalytic hydrogenation to methane takes place

The catalytic methanation unit with will be able to convert the raw biogas and the carbon dioxide released by the upgrading unit to synthetic natural gas. The conversion is carried out by means of Sabatier reaction and the necessary hydrogen is produced on-line through alkaline electrolysis under pressure at 12 bar (37 kW). Then, hydrogen will be mixed with the carbon dioxide source, preheated and introduced to compact reactors with advanced catalysts to obtain the synthetic natural gas. The integration of renewable energy to the electrolyzer allow the synthetic natural gas to be a renewable gas. The two demonstration units are integrated in the sewage plant together with a biogas cleaning and an analytic unit.
Cetaqua and Labaqua are the responsible for the membrane biogas unit, IREC and Gas Natural Fenosa for the biogas methanation unit and catalyst development.

Acknowledgements
Authors are gratefully acknowledge the funding of this work by CoSin project (COMRDI15-1-0037), funded by ACCIÓ.



Cosin process simple.jpg

Plant overview.jpg

Experimental study and performance evaluation of a small-scale CAU10-H coated heat exchanger structure

Wednesday, 25th April - 16:40 - Thermal energy and building performance - Room 207 - Oral - Abstract ID: 335

Mrs. Türkan ÜÇOK ERKEK [1]***, Prof. Ali Güngör*** [1]***, Mr. Hannes Fugmann*** [2]***, Dr. Alexander Morgenstern*** [2]***, Mr. Paolo Di Lauro*** [2]

1. *Ege University,* ***2.*** *Fraunhofer Institute for Solar Energy Systems ISE*

Desiccant-based dehumidification systems enable higher energy efficient control of indoor air humidity. These systems can withdraw moisture in a cost-effective way than the sensible heat. Solid desiccant systems are also to be adapted to use solar thermal or waste heat as an energy source which carries off its energy saving potential one step further. These systems would offer good prospects beyond its current value when the cost reduction and performance improvement are handled.

Desiccant coated heat exchangers recently gather much attention among research communities and industrial companies by the aspect of energy savings. Metal-organic frameworks (MOF) are declared to possess several good qualities such as condensation pressure of water in the pores, uptake capacity, and recyclability and water stability of the material. CAU-10-H is a MOF which good stability is reported in recurrent water adsorption and desorption cycles. In this work, the experimental studies related to the sorptive coated heat exchanger structure have been accomplished at a test bench which is specially designated for measurements of small samples. Water uptakes derived from experimental data for the heat exchanger structure is well correlated with the adsorption and desorption isotherms of CAU-10-H. Regeneration and dehumidification efficiencies, as well as the mass of adsorbate removed from the air, are calculated for the experimental results. Results have shown that CAU-10-H coated heat exchanger structure can remove a reasonable amount of moisture from the process air.

Strategic heat planning: A spatial approach for urban areas

Wednesday, 25th April - 16:57 - Thermal energy and building performance - Room 207 - Oral - Abstract ID: 34

Mr. Jürgen Knies [1]

1. *Jade University of Applied Sciences Oldenburg*

Introduction

The current climate protection goals will lead to unprecedented and profound changes to energy systems. The transition to a decarbonized heat supply system will be complex and the process will have deep impacts on the urban subsystems (technical, economic, social and planning subsystems) with different spatial extents. For decision making in this context, the level of individual buildings provides a perspective which is too narrow. On the other hand, a very broad view is also unhelpful for the local transition process. The study takes place in the cities of Oldenburg (ca. 160 000 inhabitants), Bramsche and Wallenhorst (ca. 53 000 inhabitants), all in Germany.

Methods

Depending on the heat density, different options of future heat supply systems and their degree of suitability (from single supply systems via island solutions to 4th generation district heating systems etc.) are mapped. This also involves an assessment with regard to future heat demand and reduction scenarios.

The linear heat density is estimated, and the suitability is calculated by fuzzy membership (Fig. 1) and mapped. Different parameters, like edge effect, the different structure of the settlements, the influence of the shaping etc., are evaluated in order to demonstrate the robustness and the limits of the approach.

Additionally, the possibilities of integrating industrial waste heat and solar energy are taken into account by spatial matching of demand and supply on a strategic level.

Results

The spatial conceptualization of the suitability areas leads to coherent areas for the subsequent planning level (Fig. 2). The mapping of the scenarios gives a first overview of possible developments in space and time (Fig 3). The energy balances of excess heat and PV power on a strategic level shows in which areas the subsequent energy planning could modify the focus of the energy concept.

Discussion

At the subsequent planning level, the results can be used as guard rails to make the urban planning process more consistent and transparent. The limits of the approach are also its strengths: Detailed energy planning has to follow this first step. However the data-driven suitability areas are communication bridges between urban planners and energy planners.

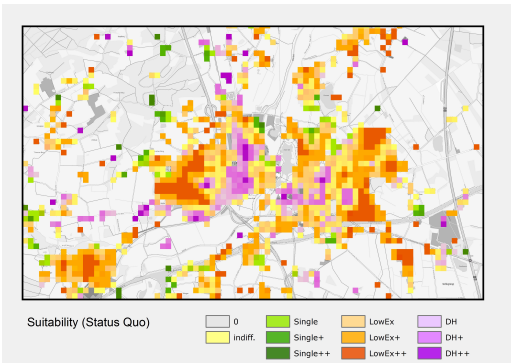


Fig02 statusquo.jpg

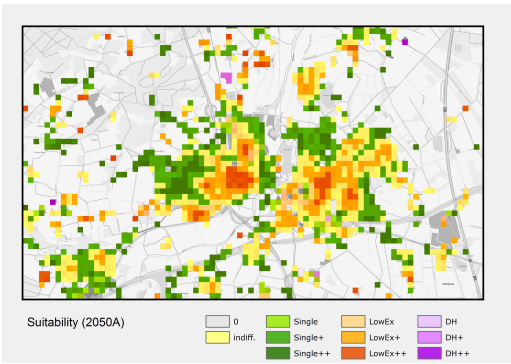


Fig03 scenario 2050a.jpg

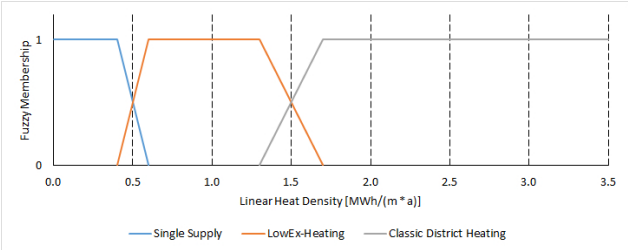


Fig01 fuzzymembership.jpg

Flat-plate radiative cooling and solar thermal collector numerical model evaluation.

Wednesday, 25th April - 17:14 - Thermal energy and building performance - Room 207 - Oral - Abstract ID: 209

Mr. Sergi Vall [1], Dr. Kévyn Johannes [2], Dr. Damien David [2], Dr. Albert Castell [1]

1. *University of Lleida,* ***2.*** *Université Lyon 1*

Introduction

Low-grade energy sources are making way in building energy supply of domestic hot water, space heating and cooling. One of these sources is radiative cooling which takes advantage of the sky as heat sink. However, some improvements are required and its coupling with solar collection is seen as a promising solution.

Little research has been conducted in this issue, and there is no research in the development of a numerical model capable of reproducing this combination of technologies.

Methodology

A numerical model coupling both technologies is developed and presented. The model is implemented in TRNSYS as a new type. Special care was taken in the definition of the radiation model.

Results and discussion

Results show the potential of the RCE to perform the double functionality, as solar thermal collector and as radiative cooler. For spring period, the solar thermal energy collected is 10.90 kWh/m2 and radiative cooling energy is 1.60 kWh/m2, whereas for the summer period the solar thermal energy collected is 14.96 kWh/m2 and radiative cooling energy is 0.88 kWh/m2.

Results demonstrate the potential of this technology leading to the next step of developing an experimental prototype.

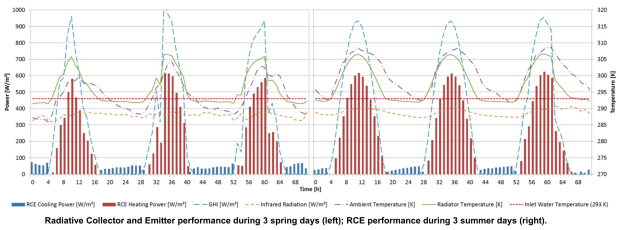


Figure abstract.jpg

Geothermal energy for drying of wastewater sludge and electricity production

Wednesday, 25th April - 17:31 - Thermal energy and building performance - Room 207 - Oral - Abstract ID: 98

Dr. Simona Di Fraia [1], Dr. Adriano Macaluso [1], Prof. Nicola Massarotti [1], Prof. Laura Vanoli [2]

1. *Università degli Studi di Napoli 'Parthenope',* ***2.*** *Università degli Studi di Cassino e del Lazio Meridionale*

Waste treatment and disposal and electric energy production are crucial challenges in geographically disadvantaged areas, such as small islands, due to limited connection with mainland. Scarce land availability, environmental restrictions and tourism activity, that often characterize small islands, make difficult to adopt ordinary technical solutions, increasing these issues. Then, the most common strategy for waste disposal is shipping to the mainland, whereas electricity generation is based on the importation of fossil fuels for local production. Both these options make small islands strongly dependent on the mainland, and cause significant energetic, environmental and economic costs. For these reasons, the use of renewable energy sources for waste treatment and energy production is particularly attracting in small islands.

In this work, geothermal energy at medium enthalpy is considered to produce heat for thermal drying of wastewater sludge and to power an Organic Rankine Cycle system for electric energy production. The analysis is carried out for the case study of a small Italian island.

The geo-fluid, through an air-water heat exchanger, heats fresh air to produce the desiccant current for sludge drying, which is carried out by using a belt convective dryer, operating in the range of 90.0-180°C. The dryer is designed to achieve a final solids content of dry sludge higher than 90.0%. A fraction of the desiccant current exiting the dryer is recirculated in order to reduce thermal energy demand of the dryer and, at the same time, the flow rate of exhausts to be treated. Before reinjection, the geo-fluid powers a small-scale ORC system, designed to self-supply the proposed layout, providing electricity for the dryer and the geo-fluid pumps, and to produce electricity for the wastewater treatment facilities.

An energy analysis of the proposed system is carried out through the software Aspen PLUS, and an economic and environmental model is developed to assess its profitability. This model estimates the economic and environmental benefits coming from sludge drying, which significantly decreases the amount of sludge to be transported and disposed, and from the use of a renewable energy source with respect to conventional fossil fuels, for sludge treatment and electric energy production.

Is waste plastics the next important energy source?

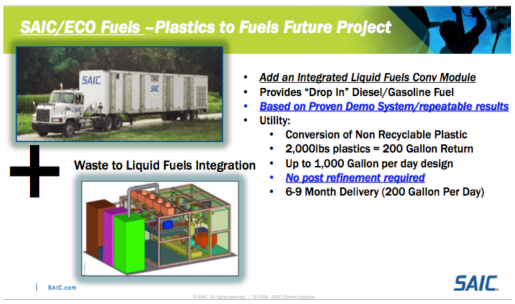
Wednesday, 25th April - 17:48 - Thermal energy and building performance - Room 207 - Oral - Abstract ID: 179

Dr. swaminathan ramesh [1]

1. *EcoFuel Technologies, Inc*

Humans have produced over 15 trillion pounds of plastics, starting from 1950. While the plastics have very desirable properties like light weight, mold-able into many, many shapes and forms, strong, perfect for sanitary and transportation packaging, their very durability means all the plastic produced are still present, clogging up our oceans, beaches and land. If unchecked, it is predicted that there will be more plastic than fish in the ocean by 2050. Since they can absorb and concentrate toxins around them, some by a million fold, pose substantial health risk for fish, animals and humans. Many countries are talking about banning plastics outright.
The problem is not plastics, but the single use and discard culture. Most forms of the plastics have similar energy density as diesel or gasoline. If this energy can be captured in an economical and business positive way, theoretically we can produce a minimum of 1 trillion gallons of diesel.

Pyrolysis under inert atmosphere is technologically a successful process to de-polymerize many types of plastic into 'plastic oil' - equivalent to crude oil. However, big plans to deal with the available plastic always ended up as business failures. The cost associated with transporting huge volumes of plastic and the plastic oil to the refineries made it impossible to turn a profit if the crude is less than $60 a barrel.
EcoFuel Technologies (EFT) has taken a different approach. Its catalyzed pyrolysis can be run as a continuous process with its reactor having a small footprint. A Plastic to Fuel (PTF) unit capable of processing 10000 pounds a day can be mounted on an eighteen wheel truck. It can go where the plastic are. Another important difference is it can directly produce diesel in very high yield from a mixture of polyethylenes, polypropylene and 20% polystyrene, making the product it at least 200% more valuable than plastic oil.
We envision placing a number of such portable PTF units where it is justified to clean up the plastic waste, produce high quality fuel and help the local economy. We can operate on land or water.



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Ptf200.png

Power Electronics — The Key Technology For Renewable Energy System Integration

Thursday, 26th April - 09:00 - Plenary Speeches - Auditorium - Oral - Abstract ID: 116

Prof. Frede Blaabjerg [1]

1. *Aalborg University*

The energy paradigms in many countries (e.g., Germany and Denmark) have experienced a significant change from fossil-based resources to clean renewables (e.g., wind turbines and photovoltaics) in the past few decades. The scenario of highly penetrated renewables is going to be further enhanced– Denmark expects to be 100 percent fossil-free by 2050.

Consequently, it is required that the production, distribution and use of the energy should be as technologically efficient as possible and incentives to save energy at the end-user should also be strengthened. In order to realize the transition smoothly and effectively, energy conversion systems, currently based on power electronics technology, will again play an essential role in this energy paradigm shift. Using highly efficient power electronics in power generation, power transmission/distribution and end-user application, together with advanced control solutions, can pave the way for renewable energies. In light of this, some of the most emerging renewable energies — , e.g., wind energy and photovoltaic, which by means of power electronics are changing character as a major part in the electricity generation —, are explored in this presentation. Issues like technology development, implementation, power converter technologies, control of the systems, and synchronization are addressed. Special focuses are paid on the future trends in power electronics for those systems like how to lower the cost of energy and to develop emerging power devices and better reliability tool for system assessment.

The Largest Rotating Machines on Earth

Thursday, 26th April - 09:40 - Plenary Speeches - Auditorium - Oral - Abstract ID: 441

Prof. Carlo L. Bottasso [1]

1. *Technical University of Munich & Politecnico di Milano*

Although many different factors have contributed to the reduction in CoE, one aspect of the design of wind turbines that clearly stands out is the increase in size, both for onshore and offshore applications. Larger swept areas and taller towers are the principal causes behind the increased energy yield of modern designs. This has not only lead to improved capacity factors, but it is also enabling the penetration of wind into geographical areas with lower average wind speeds, which were once not economically viable.

However, design challenges are not only related to size. A better understanding of the physics, improved modeling and analysis capabilities, increased experience, better manufacturing processes and an overall steady maturation of technology is pushing industry to seek more optimized designs. As a result, blades have become not only more aerodynamically efficient, but also slender, lightweight and flexible, while towers are not only taller but also softer than in earlier designs. Indeed, we are quickly moving from the era of loads, dominated by stiff designs, to the new era of flexibility, where aeroelasticity and controls play a bigger role. A consequence of this general trend is the need to include early on in the design process all those aspects that, by their mutual interactions, affect the performance, life, safety, operation and maintenance of a wind turbine.

In fact, as already seen for other similarly complex engineering applications, an improvement in the sophistication of the technology and more optimal and less conservative designs require automated multidisciplinary design procedures implemented in advanced computer programs. Multidisciplinary design analysis and optimization (MDAO) tries to address these needs, by providing automatic procedures that translate the design process into a constrained optimization and numerically solve the resulting problem. Automated design codes are clearly not meant to replace the experienced designer, but they can greatly improve knowledge and understanding of the design space, leading to better solutions and reduced development times.

This presentation discusses models and methods for the automated design optimization of wind turbines. This discipline is relatively new, and it is expected to quickly evolve in the years to come.

Nanocatalysts to turn carbon dioxide and water to carbon-neutral synthetic fuels.

Thursday, 26th April - 10:45 - Plenary Speeches - Auditorium - Oral - Abstract ID: 93

Dr. Teresa Andreu [1]

1. *Catalonia Institute for Energy Research (IREC)*

An important approach towards an efficient and sustainable economy is storing the surplus of renewal energy into chemicals through water splitting and CO_2 reduction, to convert them in carbon-neutral synthetic fuels. To this end, several technologies can be pursued, from photocatalysis, electrolysis or thermochemical conversion, and thus, catalysis is playing a major role in the activation of the stable water and carbon dioxide molecules. To find the suitable processes, together with new cheap and earth abundant nanocatalysts adaptability is mandatory for large scale industrialization and deployment of the novel technologies.
In this talk, it will be presented the recent advances in our laboratory in the production of solar fuels by photoelectrocatalysis and low temperature CO_2 electrolysis as well as CO_2 conversion from biogas by conventional thermocatalytic hydrogenation and plasma-catalysis. For upscaling the technology, a mandatory focus on the selectivity, productivity, costs and energy efficiency should be taken into account as well as a discussion on the intrinsic limitations of some of the processes, to look at the future challenges for its practical implementation to replace fossil fuels.

Renewable Energy across Scales

Thursday, 26th April - 11:25 - Plenary Speeches - Auditorium - Oral - Abstract ID: 358

Prof. AbuBakr Bahaj [1]

1. *University of Southampton*

Over the last two decades, sustainable energy technologies have become a critical part and a major contributor to the global energy supply mix especially in the electricity sector. This is driven by many factors: (i) our desire to use sustainable resources to reduce pollution emanating from the current use of fossil fuels, (ii) to provide a pathway to achieve national and internationally agreed emission reductions (iii) increasing energy security through local resource utilisation, and (iv) the creation of jobs and new industries. Although some of the sustainable energy technologies are in some cases, still driven by what is termed as support mechanisms or subsidies, the sustainable or renewable energy industry has matured, with huge investments being ploughed into it globally. Global new investment in renewable energy (excluding large hydro-electric projects) was around US$241.6 billion in 2016, with over 138.5GW of added renewable power capacity worldwide. This capacity is equivalent to 55% of all the generating capacity and was approximately double that in fossil fuel generation in 2016. A large proportion of the investments have targeted solar and wind electrical power generation. These activities provides the real evidence that renewable energy is now a major industry sector that is likely to grow further, displacing and augmenting traditional electricity generation facilities as we progress in this century. This paper addressed renewable energy technologies and gives a discourse of status of these technologies, their applicability across a wide range of consumption needs and policy implications for future expansion. The paper covers solar, wind, and marine energy and includes economic assessment as well as future prospects for such technologies. Further discussion is also provided for renewable energy deployment at different scales including installations at building, village, city and in farms or arrays.

Low Temperature Plasma Processes: From Silicon Thin Films to Epitaxial Growth and Nanostructure for Photovoltaics

Thursday, 26th April - 13:30 - Plenary Speeches - Auditorium - Oral - Abstract ID: 446

Prof. Pere Roca Cabarrocas [1]

1. *Ecole Polytechnique*

Silicon thin film technology has been driven by hydrogenated amorphous and microcrystalline silicon thin films which are routinely produced using silane plasmas. While SiH3 is often considered as the main radical for the obtaining of such films, we have shown that changing the process to conditions where silicon clusters and nanocrystals are produced in the plasma can lead to high deposition rates and improved materials, such as hydrogenated polymorphous silicon and polycrystalline silicon [1]. Moreover, by changing the substrate from glass to crystalline silicon, it is possible to produce epitaxial crystalline silicon films (c-Si:H) which can be transferred to foreign substrates [2,3]. Interestingly enough the structure of c-Si:H films is found to be tetragonal, indicative of their particular growth process [4]. Even more interesting, this low temperature epitaxial process can be extended to doped films as well as to germanium and silicon-germanium alloys and their heteroepitaxial growth on GaAs [5], which opens they way to low cost and high efficiency tandem solar cells. Last but not least, combining PECVD with low melting temperature metal nanoparticles such as indium and tin leads to the growth of nanowires (including Ge, Si and GeSn), which allow to achieve efficient light trapping and carrier collection in radial junction solar cells [6] or even to growth the c-Si nanowires in-plane for stretchable electronics and photonics applications [7].

[1] Ka-Hyun Kim et.al. Sci. Reports 7 (2017) 40553.
[2] R. Cariou et. al. Prog. in Phot.: Research and Applications **24** (2016) pp. 1075-1084
[3] A. Gaucher et. al. NanoLetters **16** (2016) 5358
[4] Wanghua Chen, et.al. Crystal Growth and Design **17(2017)** 4265
[5] Gwenaëlle Hamon, et.al. *J. Photon. Energy* **7**(2), 022504 (2017)
[6] S. Misra et. al. J. Phys. D: Appl. Phys. **47** (2014) 393001.
[7] Zhaoguo Xue et.al. Nature Communications 7 (2016) 12836

Transition Metal Ammoniates – A Novel Class of High-Performance Thermochemical Energy Storage Materials

Thursday, 26th April - 16:10 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 103

***Dr. Danny Müller* [1], *Dr. Christian Knoll* [1], *Dr. Jan Welch* [1], *Mr. Werner Artner* [1], *Dr. Klaudia Hradil* [1], *Prof. Michael Harasek* [1], *Prof. Andreas Werner* [1], *Prof. Peter Weinberger* [1]**

1. *Technische Universität Wien*

Effective compensation of the temporal differences for peaks in energy production and demand is a major challenge for integration of renewable and sustainable energy sources into the existing energy supply chain. This becomes acute when combining sustainable energy management with fluctuating energy sources as the sun, as they feature non-operational times at *e.g.* night. To store excess heat for use during low-production times, efficient thermal storage is necessary. Thermochemical energy storage (TCES) is acknowledged as highly efficient, still rather experimental method for thermal energy storage, mainly due to low cycle stabilities and long reaction times.

High-performance TCES materials require maximal volumetric energy storage potentials.[1] Aiming for materials applicable between 25 °C - 400 °C, transition metal ammoniates were so far largely uninvestigated. A systematic study on chlorides and sulphates, investigated for their performance as TCES-materials reversibly forming ammoniate complexes in the presence of gaseous ammonia, is presented. Regarding the energy density and compared to other TCES- materials operated in the temperature window between 25 – 400 °C, transition metal ammoniates are amongst the most attractive energy storage materials reported (fig.1): For the chlorides a maximum of 2.43 MWh m^{-3} ($NiCl_2$), and for the sulphates of 1.72 MWh m^{-3} ($CuSO_4$) was observed. Especially in the case of $CuSO_4$ a perfect cycle stability was observed.[2]

$CuSO_4$ and $CuCl_2$ were investigated in a laboratory scale reactor (fig.2). After 80 seconds peak temperatures of 312 °C and 238 °C respectively were achieved.[3] Careful selection of the temperature profile during the charging and discharging reaction allows for cascadic energy storage, addressing different temperature levels.

The contribution presents and compares experimental results on a widely neglected class of thermochemical storage materials, featuring highly attractive properties combining small scales and high storage densities for *e.g.* solar heating.

[1] M. Deutsch, D. Müller, C. Aumeyer, C. Jordan, C. Gierl-Mayer, P. Weinberger, F. Winter, A. Werner, *Appl. Energy,***2016**, *183*, 113-120.

[2] D. Müller, C. Knoll, C. Jordan, J.M. Welch, A. Werner, M. Harasek, P. Weinberger, *Appl. Energy,***2017**, *submitted.*

[3] D. Müller, C. Knoll, G. Gravogl, A. Werner, M. Harasek, R. Miletich, P. Weinberger, *ISES Proceedings*,**2017**, submitted.

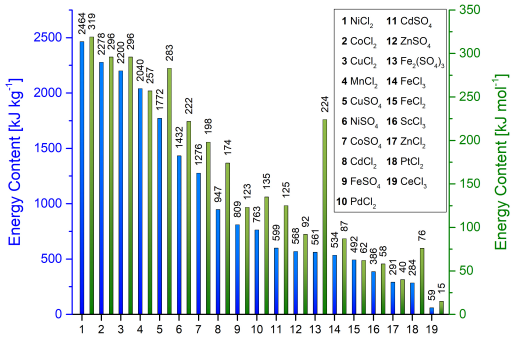


Fig.1 energy content of the investigated transition metal salts.jpg

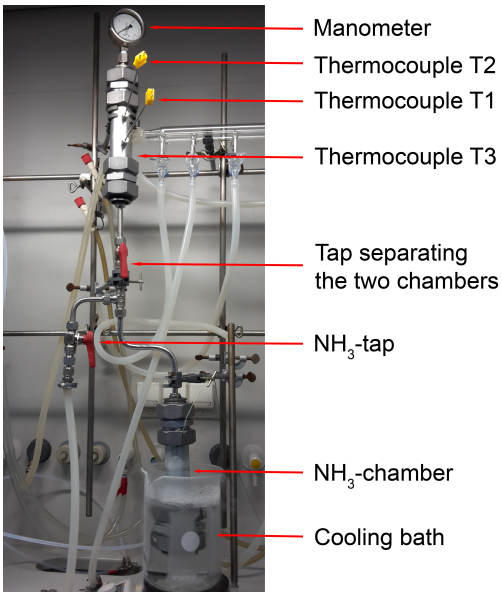


Fig.2 laboratory scale reactor.jpg

Calcium doped Magnesium Oxide as improved Material for Thermochemical Energy Storage

Thursday, 26th April - 16:27 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 97

Dr. Christian Knoll [1], ***Dr. Danny Müller*** [1], ***Mr. Thomas Ruh*** [1], ***Mr. Werner Artner*** [1], ***Dr. Jan Welch*** [1], ***Prof. Herwig Peterlik*** [2], ***Prof. Michael Harasek*** [1], ***Prof. Peter Blaha*** [1], ***Dr. Klaudia Hradil*** [1], ***Prof. Andreas Werner*** [1], ***Prof. Peter Weinberger*** [1]

1. *Technische Universität Wien,* ***2.*** *university of vienna*

Thermochemical energy storage (TCES) is considered as auspicious method for sustainable energy management, allowing for decreased energy consumption by recycling of waste heat.

Materials for a technological implementation of TCES processes should be cheap, highly cycle stable, show fast reaction kinetics and be completely reversible. $Mg(OH)_2$ undergoes calcination and partially reversible hydration and is available in large quantities.[1] With calcination temperatures around 400°C it is also compatible with many industrial waste heat sources.[2] So far low cycle stability and incomplete hydration of MgO impede application, so the target of this study was to increase the performance of the material conserving low calcination temperatures.

Compared to MgO, the hydration of CaO is considerably faster and more exothermic. The reason for this varying behaviour is due to the kinetic barrier of the water dissociation on the oxide surface. This barrier is significantly smaller for CaO favouring the water dissociation, leading to rapid $Ca(OH)_2$ formation.

The approach for this study was to dope MgO with Ca^{2+} to enhance the lattice parameters and utilize the favoured water dissociation behaviour on the surface. By calcination of a mixed $Mg_{1-x}Ca_x(OH)_2$ precipitated from a solution of calcium and magnesium chlorides, the immiscibility of MgO and CaO could be circumvented.[3] Both the fundamental nature of mixed calcium-magnesium oxide-hydroxide systems as well as their rehydration kinetics were investigated while utilizing the lower reaction temperatures of magnesium-based materials.

The resulting mixed oxides revealed a much higher rehydration rate compared to pure MgO. $Mg_{0.9}Ca_{0.1}O$ was found to show the highest reactivity with full rehydration conversion within 80min and remarkably enhanced cycle stability. DFT calculations and X-ray diffraction reveals that this improved behavior results from enhanced lattice parameters and not from physical mixture of MgO and CaO.

[1] Y. Kato, Y. Sasaki, *et al.*, *Magnesium oxide/water chemical heat pump to enhance energy utilization of a cogeneration system.* Energy, 2005. **30** (11-12): p. 2144-2155.

[2] D. Müller, C. Knoll, *et al.*, *In-situ rehydration of MgO obtained by low temperature calcination*ChemSusChem, 2017. **submitted**

[3] D. Müller, C. Knoll, *et al.*, *Calcium Doping Facilitates Water Dissociation in Magnesium Oxide.* Advanced Sustainable Systems, 2018. 10.1002/adsu.201700096

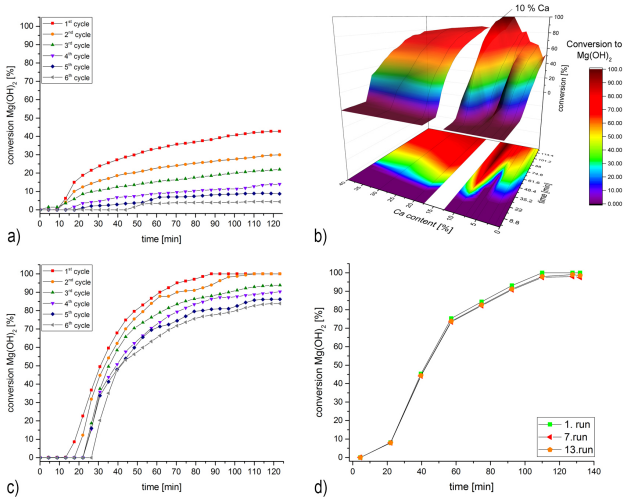

1st cycle
2nd cycle
3rd cycle
4th cycle
5th cycle
6th cycle
conversion Mg(OH)2 [%]
time [min]
a)
10 % Ca
Conversion to Mg(OH)2
conversion [%]
Ca content [%]
b)
c)
1. run
7.run
13.run
d)

Fig.1.jpg

Manganese–iron binary oxide for solar thermochemical energy storage

Thursday, 26th April - 16:44 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 258

Ms. Marziyeh Hamidi [1], ***Dr. Alicia Bayon*** [2], ***Mr. Mark Wallace*** [3], ***Dr. Peter Kreider*** [1], ***Dr. Vincent Wheeler*** [1], ***Dr. Takuya Tsuzuki*** [1], ***Prof. Kylie Catchpole*** [1], ***Prof. Alan Weimer*** [3]

1. *The Australian National University,* ***2.*** *CSIRO,* ***3.*** *University of Colorado Boulder*

Electricity can be generated from heat stored in molten salt for less than \$0.03/kWh$_{el}$, which is far less than an aggressive \$0.10/kWh$_{el}$ estimate for future battery storage[1]. Although numerous metal oxide systems have been investigated for thermochemical energy storage (TCES) redox processing to improve on molten salt storage, none of these systems has fulfilled all the requirements of an ideal storage material (low cost, robustness, safety, and high energy density). For instance, pure manganese oxide is an inexpensive material that reacts at an acceptable temperature and has a moderate reaction enthalpy. However, its re-oxidation reaction is slow and its cyclability (robustness) is poor. On the other hand, iron oxide has a much higher reaction enthalpy and faster reaction kinetics, but suffers from a relatively high reduction temperature and deactivation upon sintering. Recent work has focused on a binary 1:3 Fe_2O_3:Mn_2O_3 system as a possible TCES system[2]. However, it seems likely that a higher Fe content will be desirable for faster kinetics and improved energy storage.
So, in this work, a binary mixture of 2:1 Fe_2O_3:Mn_2O_3 which forms iron manganese oxide spinel ($MnFe_2O_4$) on calcination is investigated as a potentially suitable TCES material. The XRD patterns in Figure 1 prove the presence of cubic spinel phase for the reduced state and show a bixbyite phase for the oxidized state of the material. The reduction reaction of this system has been studied using Thermogravimetric Analysis (TGA). Master plot analysis (Figure 2), and multivariate non-linear regression (Figure 3) are used to identify the reaction mechanism and its associated kinetic parameters for inert gas reduction. The reduction reaction follows the first order mechanism and the reaction rate law is da/dt=3.077e+11exp(-296/RT)(1-a). Results reveal several key advantages of the proposed binary oxide system over pure manganese and iron oxides. It ensures high enthalpy of reaction and improved re-oxidation reaction behavior while preserving an appropriate reduction reaction temperature. Comparative results for reduction in air have also been studied for comparison.

[1] Branz, H.M. et al., Energy & Environmental Science, 8, 3083 (2015)
[2] Wokon, M et al., Solar Energy, 153, 471 (2017)

Electricity Generation by Urban Infrastructure: Zero Emission 2018-2050

Thursday, 26th April - 17:01 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 155

Dr. Peter Harrop [1]

1. *IDTechEx*

This presentation shares market research from the IDTechEx report, “Electricity Generation by Urban Infrastructure: Zero Emission 2018-2050”. Cities can make all their own electricity without emissions and this presentation looks at the roadmap to 2050 for achieving this. Emphasis is on the materials and structures involved.
Cities need more electricity for reasons such as introducing water recycling, desalination and electrified transport. Part of the solution will be making electricity from ground and window area, new forms of wind energy and, since the largest cities are mostly by the sea or a river, reinvented “blue energy”. We show how this can be on a national grid, using the grid merely as back up or fully off grid. There is now some trend to go fringe of grid or off grid for security, fewer outages and lower cost. For example, the Ukrainian grid was hacked denying 225,000 people electricity in freezing conditions just before Christmas. Las Vegas casinos built their own wind farms for lower cost, fewer outages. Tesla electric vehicle charging stations are going off grid for lower cost. Saudi Arabia has a 10MW solar car park powering a high rise building. There are 110 solar road projects. We discuss how Building Integrated Photovoltaics BIPV now embraces solar windows.
Electrically smart roads, paths and parking lots are being developed with piezoelectrics, electrodynamics and photovoltaics creating electricity used for integral inductive charging of moving vehicles, deicing, structural health monitoring, interactive lighting and integral signage. Many vehicles will progress beyond dynamic charging to being Energy Independent Electric Vehicles EIEV with 1kW+ extending solar bodywork three times as efficient (eg GaAs: Hanergy, Audi etc) and wind turbines that erect when they are stationary. We assess Aerial Wind Energy commercialising at 30-100kW in 2018, quiet H-VAWT and shaftless wind turbines, ones storing energy as water and many new forms of tide, wave and river power. Overall the major trends are identified as being off grid, integration, retrofitting, reducing or eliminating batteries and, yes, cities will be able to make all their electricity, zero emission, from their infrastructure.

Thermodynamic analysis of Ceria for partial oxidation of methane and syngas production

Thursday, 26th April - 17:18 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 340

Mr. Azharuddin Azharuddin [1], Mr. Archishman Bose [1], Prof. Massimo Santarelli [1], Prof. Jordi Llorca [2]

1. *Politecnico di Torino,* ***2.*** *Polytechnic University of Catalonia*

Abstract:
Chemical looping syngas production is a two-step redox cycle, with oxygen carriers (metal oxides) circulating between two interconnected reactors. In this paper, the performance of pure CeO_2/Ce_2O_3 redox pair was investigated for syngas production via methane reduction. A comprehensive thermodynamic analysis for methane reduction and water and CO_2 splitting was performed through Gibbs free energy minimization in ASPEN Plus. The reduction reactor was studied by varying the CH_4/CeO_2 molar ratio between 0.4 and 4 along with the temperature from 500 to 1000°C. In the oxidation reactor, steam and carbon dioxide mixture oxidized the reduced metal back to CeO_2, while producing simultaneous streams of CO and H_2 respectively. Within the oxidation reactor, the flow and composition of the mixture gas was varied, together with reactor temperature between 500 to 1000°C. The results indicate that the optimal reduction condition is achieved between 900 to 950°C with CH_4/CeO_2 ratio of 0.7-0.8, while, for the oxidation reactor, it can vary between 600 to 900°C based on the requirement of the final product output (H_2/CO). The system efficiency was around 62% corresponding to an isothermal system at 900°C, and complete redox reaction of the metal oxide.
Keywords: Oxygen Carriers, Chemical looping, Syngas, Thermodynamic Analysis

Molten Salt Energy Storage for a Renewable Energy Grid

Thursday, 26th April - 17:35 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 321

Dr. William Culbreth [1], ***Ms. Kimberly Gonzalez*** [1]

1. *University of Nevada, Las Vegas*

Molten salt energy storage (MSES) is now used at two concentrating solar power plants in the southwestern United States. In both cases, solar salt is circulated through a solar collector or heat exchanger during the day to absorb heat and hot salt at 723 K is stored in a large insulated tank. Heat from the salt is transferred through a steam generator to a conventional Rankine steam cycle to produce electricity. MSES allows the plant to continue to generate electrical power at night and during intermittent cloud cover. Solar salt is a combination of potassium and sodium nitrates and their low cost and high heat capacity make them ideal for thermal energy storage. New salt mixtures have been proposed and a mixture of magnesium chloride and potassium chloride will allow operation at higher temperatures with greater thermodynamic efficiency when the heat is converted into electricity.

The low cost of photovoltaics has resulted in a significant rise in residential use in the southwestern US. Peak demand for electrical power for air conditioning extends into the evening when solar panels no longer produce power. An inexpensive storage system excess electrical power for use in the evening would help expand the use of solar power.

It is possible to efficiently convert electrical power into heat through the use of heat pumps. Heat pump performance is defined through a coefficient of performance (COP) and the COP for an ideal heat pump is the reciprocal of the efficiency of an ideal Carnot engine operating between the same high and low temperatures. Ample renewable energy from solar collectors is available only during the day and wind generators produce electrical power only when wind exceeds certain minimum speeds. Transient forms of electrical power from renewable sources can be used with heat pumps to efficiently store heat in molten salt tanks and Rankine steam cycle or CO_2 Brayton cycle engines can efficiently generate electricity upon demand. A proposed system that would employ MSES to store electrical power from renewable sources will be presented.

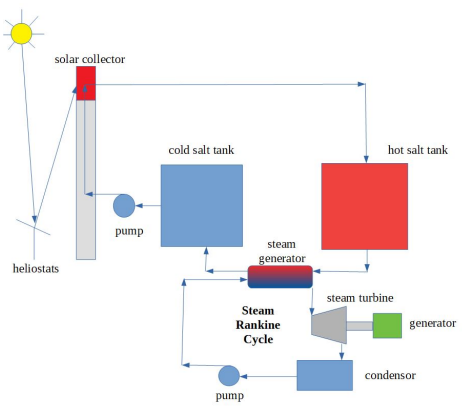


Figure 1 Molten Salt Energy Storage System for a Concentrating Solar Power Plant

Culbreth-figure 1.jpg

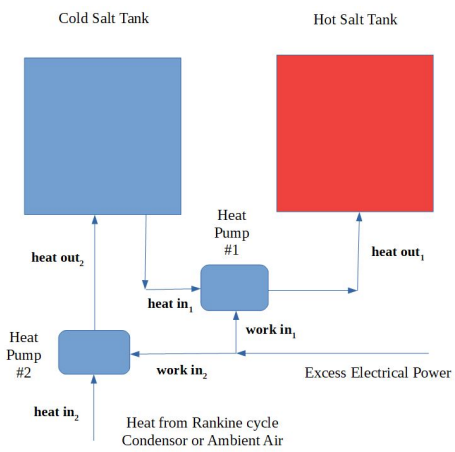
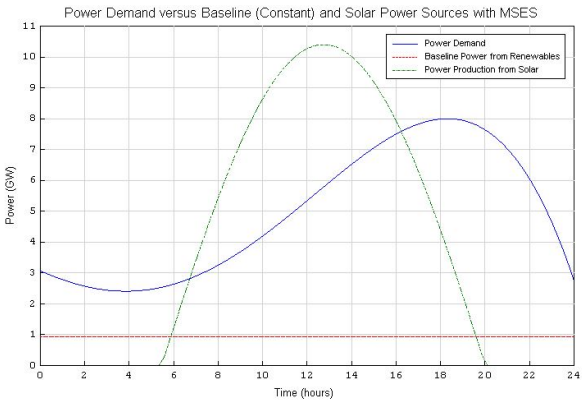


Figure 2 Heat Pump Configuration for Electrical Power Storage

Culbreth-figure 2.jpg



Culbreth-figure 3.jpg

Anisotropic radio-chemically pore-filled composite proton exchange membranes for fuel cell

Thursday, 26th April - 17:52 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 109

Dr. SYED TAUQIR ALI SHERAZI [1], ***Mr. Sajid Javed*** [1]

1. *Department of Chemistry, COMSATS Institute of Information Technology, 22060, Abbottabad*

Most electrochemical conversion and storage devices, such as fuel cells and redox-flow batteries, rely on the amazing properties of ion conducting polymer membranes. The development of polymer electrolyte membranes (PEMs) combining high ion conductivity and durability is a major challenge for materials chemistry. Nafion® (DuPont) is state of the art membrane due to its good mechanical strength, excellent proton conductivity and stability, but its limitation to low temperature operation, high cost, and fuel crossover are major obstacles that renders its usage in commercialization of fuel cell.

Various polymers have been synthesized and explored as an alternative membrane material to reduce cost and improved proton conduction to Nafion but most of these showed trade off properties. The membranes showing good conduction may have poor stability or mechanical strength. This fact impedes the technology to achieve commercialization status. In present study, radiochemical pore filled membranes were prepared in which porous polyethylene (PPE) substrate was radio-chemically grafted and filled with styrene/acrylic acid copolymer. Proton Exchange Membranes prepared through radiochemical pore filling process exhibited high ionic conductivity. High conductivity is attributed to the formation of micro level confinement within the membranes for ion transport is reported for the first time. Despite their simple preparation method, consisting single radiochemical grafting and pore-filling step using commercially available porous substrate, involves least amount of chemical. The polymer provides PEMs which exhibited exceptional proton conductivity at good but relatively lower ion-exchange capacity, as well as a high swelling resistance. An unprecedented proton conductivity of 274 mS cm^{-1} is obtained at an ion-exchange capacity of 2.85 meq g^{-1} under optimal operating conditions. The intrinsic microporosity of the charged polymer matrix offered rapid cation transport, resulting exceptional ion conductivity to the membranes at control swelling.

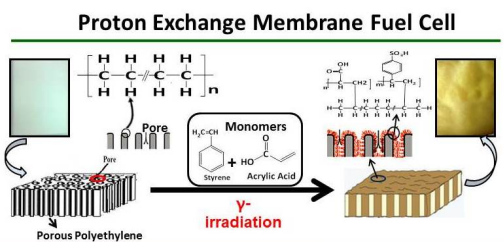


Figure 1 schematic of radiochemically pore-filled polymer electrolyte membrane.jpg

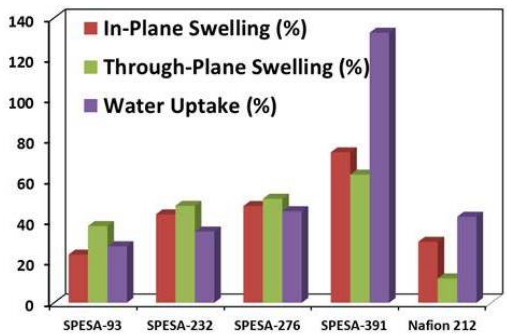


Figure 2 anisotropics swelling of pesa membranes.jpg

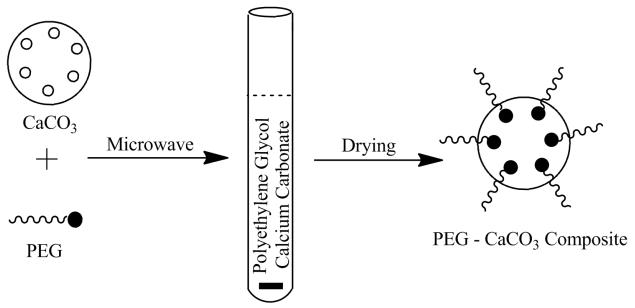
Polyethylene glycol / Calcium carbonate composite as a form stable Phase Change Material for Thermal Energy Storage

Thursday, 26th April - 18:09 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 62

Ms. Madhura Deshpande [1], ***Dr. Prashant S Kulkarni*** [1]

1. *Defence Institute of Advanced Technology, Deemed University, Pune*

With the growing demand of energy and its crisis on the environmental front, it becomes essential to develop thermal energy storage devices which can be used to bridge the gap between availability of energy and its utilisation at a desired time. Latent heat storages, in the form of 'phase change materials (PCM)' - are a part of thermal energy storages and one such upcoming area of research which has an advantage of good temperature control and high heat storage capacity. In this research, an effort has been made to use renewable sources of material to prepare PCM which can be used for building applications. To develop this, shape stabilised phase change material was prepared using polyethylene glycol (PEG) and calcium carbonate. Polyethylene glycol, the well known organic phase change material was used as a soft segment and calcium carbonate was used as the inorganic hard segment. Microwave assisted blending was used to physically blend the two components so that PEG is fixed well in the matrix of calcium carbonate to prevent its leakage above its melting temperature. It was optimised for its process parameters. Major advantages of this method was use of less solvent, ease of processing and less time required as compared to other methods, making it suitable for practical purpose. No additional containers or storages are required unlike other PCMs as they undergo solid - solid phase transitions. Form stability test or leakage test was carried out to check the same. Enthalpy of the prepared PCM was measured by differential scanning calorimetry (DSC), which was found to be 70.32 J/g. FTIR of the final composite shows the peaks of both PEG and calcium carbonate, confirming the presence of both components. It was also characterised for other supporting parameters. The detailed process of preparation and the result obtained will be presented during the conference.



Schematic representation of the blend.png

CHESS SETUP project: energy self-consumption and building retrofitting

Thursday, 26th April - 18:26 - Advanced materials for energy - Auditorium - Oral - Abstract ID: 277

Ms. Lucia Gonzalez [1]***, Mr. Gerard Riba García*** [2]***, Mr. Víctor Martínez*** [2]

1. *Edenway SL,* ***2.*** *City Council of Sant Cugat*

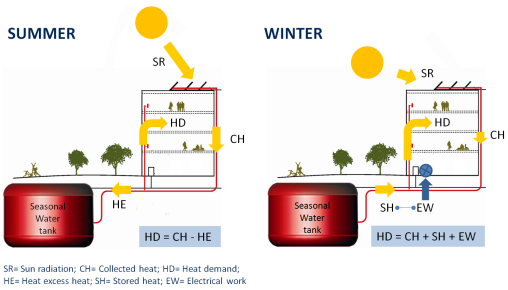
Chess Setup is a project funded by the European Commission, started in 2016 in the framework of **the H2020 program**and lead by Barcelona Ecologia. The project addresses the **growing needs of heating and domestic hot water (DHW) in the building sector**by proposing and testing a retrofitting solution based on the integration of renewable energy sources, and thermal energy storage capabilities.
The system is a combination of tested and approved technologies: hybrid photovoltaic and solar thermal (PV-ST) panels, seasonal thermal storage tanks and heat pumps. This set of tools will allow the buildings to be heating and DHW **self-sufficient during the sunny months, and to rely on their heat reserves** the rest of the year.
To ensure the **reliability** of the system, a simulation software was developed by the consortium. Indeed, taking into account the geographic location, and several parameters related to the building, it provides the **optimum dimension**s of the hybrid solar panels and of the water tank. A further analysis was held in order to select the most efficient heat pumps and mixtures to supply them.
To confirm the software's forecasts, the system **is currently being implemented** in three pilot cases including two of them in Catalonia;

- A small-scale prototype on Lavola's headquarters in Manlleu (Spain),
- At a **district-level in households**under construction Corby (United-Kingdom),
- In a sport centre in Sant-Cugat (Spain).

Later on, the consortium will study further applications for the system;

- Its ability to contribute to a **smarter grid**, supplying the main grid with electricity produced by the solar panels.
- The adaptation capacity of the system, taking into account the electricity prices and the **inertia** given by the water tank, to optimize the decision to use the heat stored, or to rely on the distribution network.

Thus, the project faces the **selfconsumption challenge in urban areas**, proposing a solution both for new buildings and existent ones.
A **business model** will be edited, in order to make the project's industrialization profitable.



Tech.png

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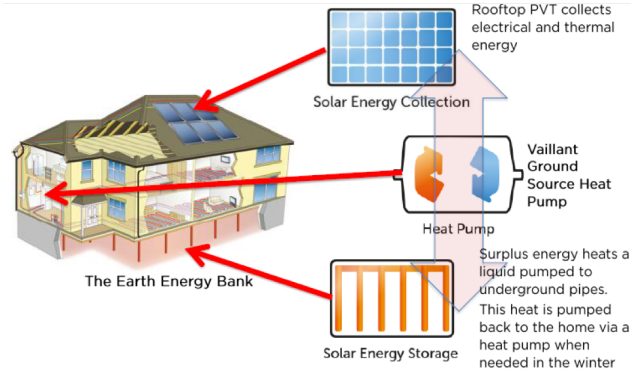

Rooftop PVT collects electrical and thermal energy
Solar Energy Collection
Vaillant Ground Source Heat Pump
Heat Pump
The Earth Energy Bank
Surplus energy heats a liquid pumped to underground pipes.
This heat is pumped back to the home via a heat pump when needed in the winter
Solar Energy Storage

Corby.png

Bio-valorization of CO2 for the sustainable production of biomethane as an alternative bioenergy storage system

Thursday, 26th April - 16:10 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 374

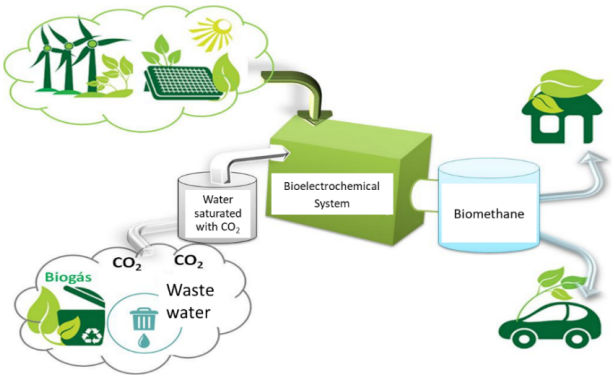
Mr. Pau Bosch-Jimenez [1], ***Dr. Daniele Molognoni*** [1], ***Dr. Edxon Licon*** [1], ***Mr. David Gali*** [1], ***Mr. Martí Aliaguilla*** [1], ***Dr. Clara Corbella*** [1], ***Dr. Mónica Della Pirriera*** [1], ***Dr. Eduard Borràs*** [1], ***Dr. John Chamberlain*** [2], ***Mr. Gerardo Romani*** [3]

1. *LEITAT Technological Center,* ***2.*** *Gas Natural Fenosa,* ***3.*** *Gas Natural Fenosa Engineering*

Power to biomethane technology reported in the present work offers a solution to employ the surplus from renewable energy sources and to reduce CO_2 emissions (from biogas upgrading or other CO_2-rich gas streams), allowing to generate fully renewable and sustainable biomethane. The present work reports a CO_2 capture and bioconversion to biomethane system as an alternative energy storage strategy. Such technology produces biomethane using a bioelectrochemical system (BES) via electromethanogenesis (BES-EMG) promotion, from a CO_2-rich gas stream, wastewater and the intermittent electricity surplus from renewable energy sources.

In view of promising future applications of electromethanogenesis for biomethane production, this work evaluates several scenarios at lab-scale: *(1)* BES-EMG reactors inoculation; *(2)* start-up; *(3)* operation strategies in a scaling-up oriented vision. In terms of inoculation, start-up and operation of BES-EMG reactors, the best results were obtained operating the reactors in a 2-electrodes configuration applying 700 mV external voltage (between anode and cathode). An average biomethane production rate of 1-2 $L_{CH4}/m^2{}_{cat}\cdot d$ was achieved, consuming a current density of 0.1 A/m^2. In a second stage, 4 BES-EMG identical reactors were operated in stack configuration and connected electrically in series, in order to increase the voltage, operating the stack at 2.8 V. A passive voltage balancing system was applied to control and limit the voltage drop at each individual cell of the stack. Developing a stack that requires a high voltage is mandatory to the future use of this technology as energy storage system with current electronic control systems.

Finally, a system to solubilize CO_2 into real wastewater (collected from the primary settler of a local wastewater treatment plant) was developed. This system allows to solubilize up to 2-4 g/L of CO_2 coming from a CO_2-rich gas stream. A wastewater with a high load of inorganic carbon was tested in a stack of 4 BES-EMG cells already operating. Results showed that current density increased up to 0.15-0.2 A/m^2 and CH_4 was enhanced up to 2.5-3 $L/d\cdot m^2$ (with 96% purity). At present, a 30 L volume prototype, composed by 45 cells connected in series and operating at a total voltage of 35 V, is under construction.



Esquema p2b.png

Production of value-added chemicals by microwave-assisted hydrothermal valorisation of glycerol

Thursday, 26th April - 16:27 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 83

Dr. Javier Remón [1]***, Mr. Guangya Zhu*** [1]***, Dr. Vitaliy L. Budarin*** [1]***, Prof. James H. Clark*** [1]

1. *University of York*

1. Introduction

Renewable biomass sources are of considerable interest because they provide an interesting route for the production of chemicals and energy. Among the different feedstocks, glycerol is of particular interest because of its ample availability as a biodiesel by-product; thus converting this feedstock into a cheap resource for which new valorisation routes need to be developed. Hydrothermal decomposition is a promising technology for glycerol valorisation, while microwave heating represents a potentially faster, more efficient and selective technology than conventional heating. Therefore, the combination of hydrothermal conditions together with microwave heating offers an interesting new technology for the valorisation of glycerol.

2. Method

Given this scenario, a novel microwave-assisted hydrothermal process has been addressed for the valorisation of a 30 wt.% glycerol solution with a Ni-Co/Al-Mg catalyst, analysing the effects of the most important operating conditions on the process. These include the temperature (150-250 ºC), pressure (50-120 bar), reaction time (0-2h) and catalyst/glycerol mass (5-15 wt.%) The experiments were planned according to a full factorial design and analysed by means of an ANOVA test.

3. Results and discussion

The statistical analysis of the results revealed that the operating conditions had a significant influence on the process. The global glycerol conversion, and the carbon converted to gas and liquids varied by 5-54%, 1-21%, 3-42%, respectively. The liquid phase was made up of mixture of monohydric alcohols (MeOH, EtOH); polyhydric alcohols (1,2-Propanediol, 1,3-Propanediol and 1,2-Ethanediol); C3-ketones (hydroxyacetone and acetone); carboxylic acids (acetic and propionic acids); together with unreacted glycerol. The carbon converted to liquids (26%) and the proportion of C3-ketones (85 wt.%) in the liquid can be maximised by using a temperature of 210ºC, a pressure of 50 bar, employing a catalyst mass of 5 wt.% for 2 h. Around 40 % of the glycerol can be purely converted to a rich mixture of monohydric and polyhydric alcohols by employing a temperature of 250 ºC, a pressure of 83 bar and a catalyst mass of 10 wt.% for 2 h. This preliminary study with glycerol suggests that this process is a very promising route for the selective valorisation of crude glycerol.

Valorization of Quercus suber bark toward hydrocarbon bio-oil and 4-ethylguaiacol

Thursday, 26th April - 16:44 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 247

Mr. Ivan Kumaniaev [1], ***Prof. Joseph Samec*** [1]

1. *Stockholm University*

A reductive process for valorization of *Quercus suber* bark towards hydrocarbons of gasoline and deiesel ranges and optionally 4-ethylguaiacol has been developed[1]. The procedure involves three steps: 1) tandem hydrogen-free Pd/C-catalyzed transfer hydrogenolysis of lignin under slightly alkaline conditions to facilitate depolymerization of suberin; 2) distillation to separate monomeric lignin derivative 4-ethylguaiacol; 3) hydrodeoxygenation of the residue in a hydrogen atmosphere in the presence of Pt-MoO_3/TiO_2 catalyst[2], yielding a range of hydrocarbons.

Yield of hydrocarbon bio-oil is 42% of dry bark weight (77% the sum of lignin and suberin contents). Carbon yield of the obtained bio-oil is 64% from total initial bark carbon. Gas chromatography showed that the obtained oil consists of C_6–C_{27} hydrocarbons (composition given in the table) and has average molecular formula $C_{14.9}H_{28.4}O_{0.00–0.06}$. H:C ratio changes throughout the process, taking a value of 1.47 for dry bark and 1.90 for the hydrocarbon oil. O:C ratio changes even more substantially: from 0.46 for bark to 0.004 for the hydrocarbonic bio-oil. Results of simulated distillation were in accordance with gas chromatography data and showed that the obtained bio-oil includes components with boiling point ranges typical for different types of hydrocarbonic fuels, such as gasoline (<200°C, 20 wt.%), diesel (200–300°C, 45 wt.%), and heavy gas oil (300–420°C, 33 wt.%). The higher heating value of such a fuel estimated for this compostion using several common linear formulas (Dulong, Boie, Mott-Spooner) is 46–49 $MJ \cdot kg^{-1}$.

Lignin domain of bark was converted into 4-ethylguaiacol with high selectivity (90%) in relation to other monomeric phenols and 12% yield from lignin mass content. Due to high degree of functionalization, this product can serve as a synthetic precursor of valuable compounds[3].

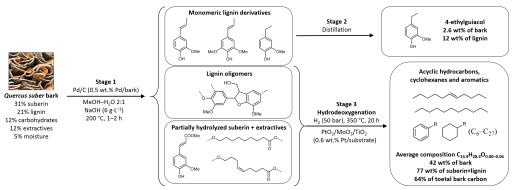
1) Ivan Kumaniaev, Joseph Samec. Valorization of *Quercus suber*bark toward hydrocarbon bio-oil and 4-ethylguaiacol. *ACS Sustainable Chem. Eng.*,Article ASAP, DOI: 10.1021/acssuschemeng.8b00537

2) K. Shimizu *et al.* Hydrodeoxygenation of Fatty Acids, Triglycerides, and Ketones to Liquid Alkanes by a Pt–MoO_x/TiO_2 Catalyst. *ChemCatChem* **2017**, *9*, 2822–2827.

3) B.F.Sels *et al.* Sustainable bisphenols from renewable softwood lignin feedstock for polycarbonates and cyanate ester resins. *Green Chem.***2017**, *19*, 2561–2570.

Type of compounds	Content, mol. %	Average molecular formula
n-alkanes	32.6	$C_{16.9}H_{35.8}$
iso-alkanes	12.3	$C_{17.3}H_{36.7}$
Cycloalkanes and alkenes	25.9	$C_{13.8}H_{27.6}$
Alkylbenzenes	7.7	$C_{11.6}H_{17.2}$
Tetralins, indans and naphtalenes	11.1	$C_{11.7}H_{14.5}$
Higher aromatics	4.5	$C_{14.5}H_{11.1}O_{0.06}$
Others	5.9	–
Total	100.0	$C_{14.9}H_{28.4}O_{0.00–0.06}$

Bark table.png



Bark scheme.png

A Novel Sustainability Performance Index for Biomass Gasification in Alternative Jet Fuel Production

Thursday, 26th April - 17:01 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 310

Dr. Ben Kolosz [1], ***Dr. John Andresen*** [1], ***Dr. Bing Xu*** [1], ***Prof. Mercedes Maroto-valer*** [1]

1. *Heriot-Watt University UK*

A novel sustainability performance index has been developed for assessing biomass waste performance during gasification of syngas for jet fuel production. Catalytic gasification of waste biomass could be an ideal sustainable production route to syngas, which through Fischer–Tropsch is upgraded into alternative jet fuels. However, a significant amount of variables affect the gasification process, resulting in possible inefficiencies. Firstly, the index consider the key gases, including CO, CO_2 and H_2, along with water and residual hydrocarbons and tars, arising from the array of reactions occurring from incomplete gasification. Secondly, it identify patterns of overall product composition which is tuned through gasification conditions including incorporation of catalytic materials, which can be typically utilised to reform the residual aromatic hydrocarbons including a tar fraction, to increase gaseous product yield. Performance between varying biomass streams under different gasifier configurations is also highly variable. Thirdly, the index uses a hybrid methodology which include a combination of system dynamics, uncertainty methods and lifecycle assessment, our performance criteria are tuned to specific biomass types as well as assessing the configuration of each gasifier type, allowing for a comprehensive sustainability analysis of gasification performance related to jet fuel production.

The empirical results reveal that by considering multiple criteria simultaneously, wood pellet biomass combined with CO_2 utilisation offers the best supply of feedstock into the gasifier mainly due to its low ash content and tar formation, as well as providing low lifecycle emissions (up to 85% reduction gCO_2e/MJ compared to conventional jet fuel) and cost. In summary, the key contribution of this paper is to propose an emission based systematic evaluation model to help the bioenergy community with ranking a set of competing choice of biomasses in terms of prioritised environmental reporting under a broad range of dimensions including lifecycle emission quotas, economic supply and demand, and energy potentials.

A Comparative Analysis of Heat Recovery and Product Stabilization in Fluid-Bed and Ablative Pyrolysis Systems

Thursday, 26th April - 17:18 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 376

Dr. Murlidhar Gupta [1], ***Mr. Benjamin King*** [1], ***Dr. Fernando Preto*** [1], ***Dr. Andrew Mcfarlan*** [1]

1. *CanmetENERGY, Natural Resources Canada*

Fast pyrolysis is a key process for converting renewable biomass residues into char, bio-oil and off gases. Rapid biomass heating and rapid vapour quenching have been the essence of fast pyrolysis in order to maximize the yield of bio-oil, but often sacrificing the quality of the bio-oil. Nearly all existing commercial pyrolysis technologies employ single-step rapid condensation of vapours from 500 ^{o}C to 50 ^{o}C using sprays of cold bio-oil or liquid hydrocarbon as a quench fluid. While single step rapid quench helps to maximize the yield of liquid product, the raw bio-oil product is a non-homogenous mixture of hundreds of oxygenated organic compounds including organic acids, and it has a significant fraction of water. One-step quench also results in high quality heat being lost to the surroundings (primarily cold water utility or ambient air) with no possibility to utilize this energy for the high-temperature heating requirements in the upstream process.

A novel 3-stage fractional condensation approach has been investigated. The intent is to produce targeted stable products for value added applications as well to enhance the overall efficiency of pyrolysis processes. The first phase of this research involved modelling and simulation of staged condensation of pyrolysis vapours using Pro/2 process software. A comprehensive pyrolysis model with 13 representative compounds was developed and validated with NREL's 2013 model built upon Aspen Plus. The Pro/2 model is able to simulate complex condensation of lignin and sugar fractions at high temperatures.

Multiple cases involving staged condensation in ablative and fluid bed pyrolysis systems were investigated. The two systems represented a low and high ratio of carrier gas to biomas, respectively. In each case, there was a trade-off between high-quality heat recovery and early separation of lignin and sugars from organic acids. Results demonstrated that judicious selection of condenser temperatures offers opportunity for early isolation of sugars and lignins from acids, thereby improving product stability. Given the high ratio of fluidization gas to biomass in fluid bed pyrolysis, dew point depression adds additional complexity and limits heat recovery.

A Study of The Effect of The Particle Size of Barley and Wheat Straw During Enzyme Hydrolysis to Produce Fermentable Sugars

Thursday, 26th April - 17:35 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 95

Mr. Mohammed Abdulsattar [1], ***Dr. Sharif Zein*** [2], ***Prof. Gillian Greenway*** [2]

1. *unviersity of Hull,* ***2.*** *university of Hull*

Agricultural waste presents an attractive source for bioethanol production, with the most important and energy-consuming step being the pre-treatment process.
Barley and wheat straw are some of the best feedstocks for bio-ethanol production due to their low price, available and relatively high sugar yield.
The aim of this paper is to study the effect of particle size on the total sugar yield during hydrolysis from barley and wheat straw. Firstly the barley and wheat straw was subjected to physical-treatment by using (Komo) grinder, the raw material was ground with different gaps between the ceramic disks and then passed through sieves to achieve different particle sizes of >2000 µm, 2000-1000 µm, 1000-710 µm, 710-500 µm, 500-250 µm and <250 µm. The hydrolysis was the performed by using Celluclast 1.5L from T. reeseiand Novozyme 188 (ß-Glucosidase) from Aspergillus enzymes. The hydrolysis was carried at 50°C and 200 rpm in a incubate shaker using 50 ml of sodium citrate buffer at pH 4.8 for 72 hr. Samples were taken every 24 hr such that a sugar yield test could be carried out by the DNS method using (UV) spectrophotometer. Further tests were then carried out for the most successful conditions using gas chromatography-mass spectrometry (GC-MS) to get the sugar compositions. The maximum sugar yield was achieved by hydrolysis of the >250 µm samples for both barley and wheat straw. The total sugar yield was 8.1 (g/l) and 7 (g/l) for barley and wheat straw, respectively. As shown in Figure 1, the results illustrated that smaller particle size gave higher sugar yield and it shows a promising sugar yield without using any chemicals or further treatment steps especially for barley straw. However, there needs to be further improvements to the process and the energy consumption needs to be reduced.

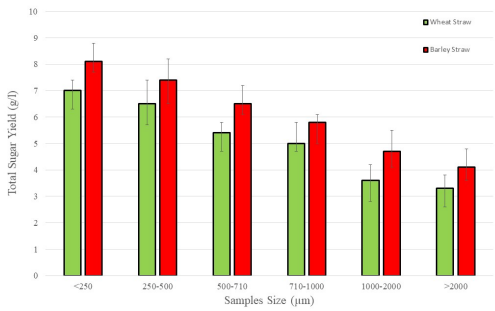


Figure 1. total sugar yield from barley and wheat straw using different particle size.jpg

Sequential extraction of microalgae biomass grown in pig manure wastewater treatment: a step further towards a bio-refinery into added-value products

Thursday, 26th April - 17:52 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 319

Ms. Judit Martin [1], ***Dr. Jelena Vladic*** [2], ***Prof. Silvia Bolado*** [1], ***Prof. Senka Vidovic*** [2]

1. *university of Valladolid,* ***2.*** *University of Novi Sad*

The valorisation of residual biomass into a variety of bio-based products and bio-energy is a highly renowned concept defined as bio-refinery. The first bio-refineries focused precisely on low-added value. However, the microalgae application has attracted interest in recent years, not only because of the energy aspect yet its high-added value compounds. Despite this, bio-refinery of algae biomass is still in its early stage and, hence, demonstration of a feasible process must be needed, making practical implementations of experimental data related to up and downstream efficiencies.

In the present, the valorisation of microalgae biomass grown in pig manure wastewater treatment was evaluated, involving sequential extraction based on a bio-refinery concept. CO_2 supercritical was applied on microalgae biomass to extract lipids. Two solid fractions were obtained: residual biomass and extracted lipid fraction. Residual biomass was used as substrate for subcritical water tests to extract proteins mainly and carbohydrates, and raw material was also used to determine the feasibility of CO_2 extraction. In the last place, the residue recovered after this process could be used as a bio-fertilizer. For this purpose, CO_2 extraction tests were performed at 100, 200 and 300 bars, and 40 and 60ºC. While subcritical water experiments were carried out at 100, 130, 160 and 190ºC for 10 min.

In this study, the chemical composition of freeze-dried microalgae biomass was 5.12% of lipids, 44.03% of proteins and 31.16% of carbohydrates. The CO_2 assays proved to extract almost all the lipid content (up to 81%), detecting an important impact on yields by increasing pressure and temperature. After that, 300 bar and 60ºC were the best conditions and, hence, its exhausted solid was used for subcritical water extraction. The CO_2 pretreated biomass reported the highest solubilisations at 190ºC, achieving 33% of released protein yields, and 67% of released sugar yields; detecting greater effect on carbohydrates than proteins. In contrast, the untreated raw material accounted higher results at low temperatures and, yet lower than found by exhausted material. Finally, the composition of solids after subcritical water extractions, with NPK higher than 7% (w/w) and C/N lower than 15, allows their use as fertilizers.

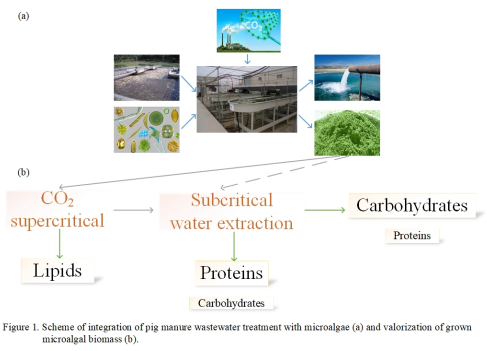


Figure 1.jpg

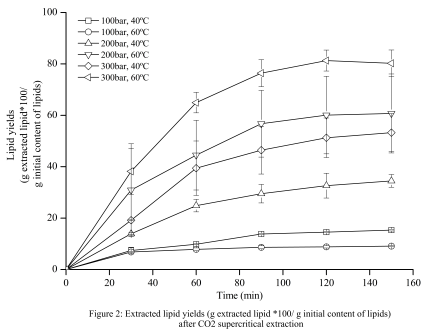


Figure 2.jpg

Modelling low-temperature gasification strategies in a floating fixed bed reactor with an ASPEN-Plus-based simulation tool SBR-Sim 3.0

Thursday, 26th April - 18:09 - Bioenergy and biomass conversion technologies - Room 207 - Oral - Abstract ID: 105

Mrs. Angela Hofmann [1]***, Mr. Reinhold Neuner*** [1]***, Mr. Franz Bekerthy*** [1]***, Mr. Robert Thaler*** [1]

1. *Managment Center Innsbruck*

The gasification of potassium-rich raw materials in the autothermal operated, floating fixed bed reactor requires adapted operating conditions in order to reduce the effects of the lowered ash melting point. One strategy is to keep the gasification temperature below a critical temperature of 800°C. Since potassium also shows a catalytic effect on the Boudouard reaction, the investigations concentrate on the effects of the lower reaction temperature on the product gas quality. The investigations were performed on the basis of an ASPEN-Plus-based simulation tool. For this, reaction kinetic data, which were previously determined in the laboratory specifically for different raw materials, were implemented via FORTRAN codes.

By changing the kinetic data of the Boudouard-reaction in the simulation model, the influence of the enhanced reaction rate on the product gas quality and the temperature profile was quantified. The main result is that an increase of the reaction rate up to a factor of 2 will influence the product gas quality positively due to an increase in the CO content and the carbon conversion rate. Furthermore, three possible measures for lowering the maximum temperature in the reactor have been simulated: splitting the gasification air in several injection nozzles, substitution of a part of the gasification air with exhaust gas of the gas engine and water injection in the air inlet. In general, all investigated methods are suitable to lower the temperature but with losses in product gas quality and cold gas efficiency. A combination of the measures is recommended to minimize the losses. Further developments will concentrate on the modification of the pilot plant by installing additional air injection nozzles and air/exhaust gas mixing devices to examine the simulated tests. The simulation data can be transferred to the pilot plant only under consideration that the geometric distribution of an air injection into the floating fixed bed shows completely different behavior than in the model. Additional measures to avoid hot spots have to be developed. With the generated test data, the simulation model has to be evaluated and, if necessary, re-fitted.

Bottom up engineering of nanomaterials for energy conversion and storage

Friday, 27th April - 09:00 - Plenary Speeches - Auditorium - Oral - Abstract ID: 449

Dr. Andreu Cabot [1]

1. *Catalonia Energy Research Institute*

Nanomaterials are particularly nanocomposites are critical components in a large number of energy conversion and storage systems. Nanomaterials maximize the interaction with the media, which is a fundamental parameter in the fields of catalysis and electrocatalysis, among other. Nanomaterials have associated lower thermal conductivities and improved mechanical properties, which are advantageous properties in the field of thermoelectricity. Additionally, nanomaterials may be able to sustain high volume changes more effectively, which is a key advantage in ion intercalation batteries. While numerous strategies to produce nanocomposites have been developed, most of them lack of a sufficient control over material parameters to fully optimize their performance, or are unpractical for real applications that require low cost and high throughput production processes. In this context, bottom up approaches that make use of colloidal nanocrystals as building blocks to engineer nanocomposites are emerging as a suitable alternative. Colloidal synthesis routes allow an extremely precise control over material parameters without particularly high capital or operating costs (ambient pressures, low temperatures) and with high-throughput production and material yields. Stimulated by its simplicity and huge potential, countless groups all over the world have developed colloidal synthesis routes to produce nanocrystals of a plethora of materials, making available an extensive library of synthetic strategies and routes to produce nanocrystals with almost any composition, size and facets. However, for such control over material parameters to truly impact real applications, colloidal nanocrystals need to be properly organized or arranged into functional unsupported superstructures, high resolution patterns, thin films, porous nanomaterials or highly dense nanocomposites, depending on the application. Such nanocrystal arrangement need to ensure proper optical characteristics, charge transport properties, interaction with the media, etc, when compared with competing technologies in each field. In this talk, I will present our work on the arrangement of colloidal nanocrystals into macroscopic nanomaterials and nanocomposites and their use for a few exemplifying applications, underlying the real advantages and remaining challenges.

Solid state electrolyte for solid state batteries and air batteries

Friday, 27th April - 09:40 - Plenary Speeches - Auditorium - Oral - Abstract ID: 7

Prof. Lu Li [1]

1. *National University of Singapore*

Solid state electrolytes have attracted tremendous attentions in recent years due largely to their commercial applications for highly safe energy storage and large energy storage devices. Although solid state electrolytes been studied for a few decades, breakthrough in ionic conductivity has been noted only recently. With applications of batteries in large format, safety issues become an extremely important in addition to challenges of high energy density. Replacement of highly flammable organic liquid electrolyte by solid and stable electrolyte leads to increased safety. Most solid electrolytes possess a wide operation potential range so that some cathodes materials that cannot be used in organic electrolyte can now be considered. Studies also note that use of solid electrolyte can significantly expand battery operation temperature range. Therefore, solid state battery is the future energy storage device. Solid electrolyte that is a key and also an essential component in the batteries can be categorized into following types: oxide, glassy, sulfate, and polymer and its composites. Different types of solid electrolytes show different advantages in different aspects. Based on safety concern, oxide-based electrolytes such as garnet-structured, nasicon-structured and lisicon-structured materials have demonstrated pretty good stability in ambient condition with reasonably high ionic conductivity of about 10-4 ~ 10-3 S/cm. Some of them can be potentially used in all-solid-state batteries and Li-air batteries. This presentation will report our recent development of solid state electrolyte for Li-air batteries and for all-solid-state batteries.

Molecular materials for solar energy conversion and energy storage

Friday, 27th April - 10:45 - Plenary Speeches - Auditorium - Oral - Abstract ID: 450

Prof. Jenny Nelson [1]

1. *Imperial College London*

TBD

Challenging the Limits of Silicon Solar Cell Performance

Friday, 27th April - 11:25 - Plenary Speeches - Auditorium - Oral - Abstract ID: 16

Dr. Wilhelm Warta [1]

1. *Fraunhofer Institute for Solar Energy Systems ISE*

Key factor for reducing the cost of electricity from PV is the conversion efficiency of solar cells. For many years technologically achievable silicon solar cell efficiencies have been seen to be limited at around 26% - until recently Kaneka's 26.7% record efficiency surpassed this limit. Such an awesome result, achieved with all the tweaks available in a sophisticated lab environment, is highly important and encouraging. Yet for providing electricity from PV at further decreasing expense, the central challenge is, how to increase the efficiencies in production at competitive cost. In the talk, for actual and for most promising solar cell concepts, status, development challenges and performance limits will be outlined. A particularly interesting route is seen in the combination of high performance multicrystalline material and cell technology using passivating contacts, developed at Fraunhofer ISE with the TOPCon structure. Pinpointing the limiting factors precisely and reporting them back to the technologists for the next optimization step we managed to achieve a world record for multicrystalline material of 22.3 %.

Partial Deoxygenation of Biomass Derived Pyrolysis Liquids

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 375

Dr. Murlidhar Gupta [1]***, Dr. Jacques Monnier*** [1]***, Mr. Eric Turriff*** [1]***, Mr. Mark Boyd*** [1]

1. *CanmetENERGY, Natural Resources Canada*

Biomass pyrolysis liquids (also known as bio-oil), are derived from renewable lignocellulosic biomass residues by fast pyrolysis process. These second-generation oxygenated hydrocarbon resources have the potential to partially substitute for petroleum-derived transportation fuels and thus enhance the economic and environmental sustainability of our natural resources. However, in contrast to petroleum fuels, biomass-derived pyrolysis liquids contain a large amount of oxygen, usually 40-50% wt% (wet basis). This undesirable high oxygen content in pyrolysis liquids is considered as the primary reason for its high polarity, high acidity, lower stability, lower energy density and very low miscibility with conventional crude refining feedstocks. There are two major pathways for upgrading the pyrolysis liquids. While hydrodeoxygenation route is one of the most explored options, it requires production and supply of large amounts of expensive hydrogen at high pressures, mandating large and centralized upgrading plants, and thus large capital investment.

In this paper, we discuss an alternative method of pyrolysis liquid upgrading, using cheap and affordable hydrogen donor additives and catalysts to promote partial deoxygenation at near atmospheric pressure. This approach is preferably to be used as a pre-treatment and stabilizing method for pyrolysis liquids in the close vicinity of remote biomass pyrolysis plants. The pretreated oil, then can be shipped for further hydrocracking process in a centralized co-processing facility. Preliminary results from the initial proof of concept experiments involving a 200g/h gas-phase continuous fast catalytic cracking system with continuous coke removal to enhance deoxygenation performance, are presented. These results indicate positive impact of catalyst bed on quality and yield of the upgraded bio-oil product in terms of pH, viscosity, degree of deoxygenation, oil yield and concentration of hydrogen in the off gases.

Characterization and catalytic hydrolysis of lignocellulosic Castor plants for bioethanol production

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 275

Mr. Harshabh Tiwari [1], ***Prof. Saikat Chakraborty*** [1]

1. *Indian Institute of Technology Kharagpur*

Second generation non-food lignocellulosic biofuels have great potential as renewable fuels. While castor oilseeds have been used to produce biodiesel [1], the lignocellulose in Castor plant (*Ricinus communis*) has never been used for bioethanol production. This study characterizes the stems and leaves of Castor oil plants to evaluate their suitability as biofuel feedstock and catalytically hydrolyzes them to biofuel precursors such as glucose, furfural and HMF, along with Levulinic and Formic Acids.

Characterization studies show that Castor leaves and stems are composed of cellulose (40.5%, with Degree of Polymerization of 1040), hemicellulose (20%) and lignin (13%). The Crystallinity Index (CI) is measured as 37% for the raw lignocellulose, and as 60% for its cellulose-rich component (Figure 1(a)). CI increases to 49% upon pre-treatment with Ionic Liquid (1-butyl-3-methyl-imidazolium chloride) and again reduces to 38% upon hydrolysis (Figure 1(b)). FESEM images of raw (Figure 1(c)), cellulose-rich, pre-treated (Figure 1(d)) and hydrolyzed (Figure 1(e)) substrates suggests that pretreatment breaks the bonds between the cellulose, hemicelluloses and lignin polymers in the pores of the lignocelluloses, exposes the cellulose to catalytic hydrolysis, while increasing the crystallinity of the substrate. FTIR Spectroscopy and CHNS Analysis (Figure 2) are performed on Raw and Cellulose-rich substrates to ascertain their bonds and the elemental compositions, while particle and pore-size analyses are performed to determine their pore structures and porosities.

Upon pretreatment with Ionic Liquid followed by catalytic hydrolysis, temporally oscillatory yields of glucose and HMF are observed for various water addition rates, with the glucose yield maximizing at 3.5 hours to 53% (w.r.t. the total carbohydrate content) for a water addition rate of 35 µl/gm of Ionic Liquid/hr (Figure 3). The oscillatory dynamics of the product yields are attributed to a reaction mechanism [2], which shows that while water catalyzes the hydration of cellulose to glucose and of HMF to Levulinic and Formic Acids, the production of HMF from glucose is a dehydration process. Thus water addition rates can be optimized to control the product distribution in the reactor.

[1] Dias, J.M., et al., Energy, 53, 58-66 (2013)

[2] Paul, S.K., Chakraborty. S., Bioresource Technology, 253, 85-93 (2018)

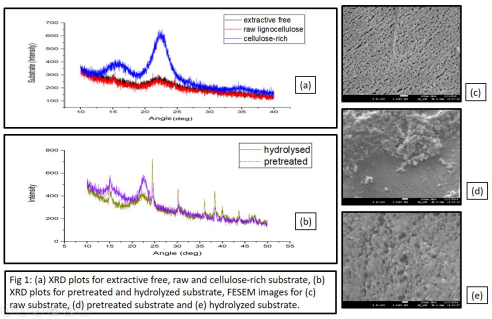


Fig 1: (a) XRD plots for extractive free, raw and cellulose-rich substrate, (b) XRD plots for pretreated and hydrolyzed substrate, FESEM images for (c) raw substrate, (d) pretreated substrate and (e) hydrolyzed substrate.

Figure 1.jpg

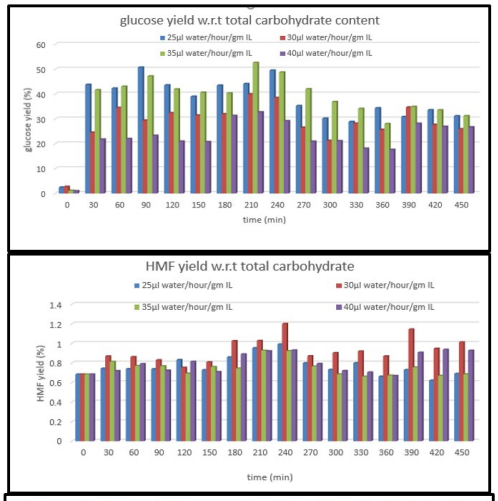


Figure 3: yields of glucose and HMF w.r.t total carbohydrate present in the substrate.

Figure 3.jpg

Fig 2. (a) Fourier Transform Infrared Spectroscopy transmittance curve for raw lignocellulose and cellulose-rich substrate. (b) CHNS comparison of raw lignocellulose and cellulose rich substrate.

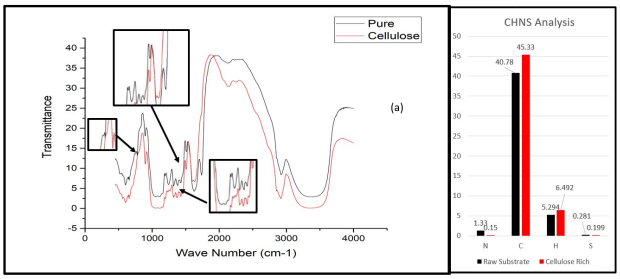


Figure 2.jpg

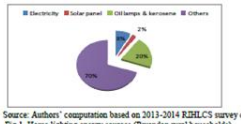
Solar Photovoltaics and Home Lighting Fuel Choices: Evidence from Rural Households in Rwanda

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 327

Ms. Fydess Khundi Mkomba [1], Prof. Etienne Ntagwirumugara [2], Prof. Umaru Garba Wali [3], Dr. Akshay Kumar Saha [4]

1. *PhD student, University of Rwanda, African Center of Excellence in Energy for Sustainable Development, College of Science & Technology,* ***2.*** *University of Rwanda,African Center of Excellence in Energy for Sustainable Development, College of Science & Technology,* ***3.*** *Professor of Water and Environmental Engineering, Dean, School of engineering University of Rwanda, College of Science & Technology, Nyarugenge Campus, Kigali, Rwanda,* ***4.*** *School of Engineering, Howard College Campus,University of KwaZulu-Natal*

The high dependency on traditional fuels in Rwanda has been associated with limited access to national grid electricity especially in the rural areas with slight progress on renewable energy interventions such as usage of solar panels as indicated by the indicators on the sustainable energy for all. "What are the interventions needed to reduce rural household energy poverty in Rwanda?" This paper utilized the 2013/2014 Rwandan Integrated Household Living Conditions survey dataset to address this policy question. The results from a multinomial probit model shows that poverty, education levels, access to environmental information and location factors are some of important factors that determine and influence solar photovoltaic uptake and rural home lighting fuel choices in Rwanda. An important finding of this study is that a considerable number of rural wealthy households are using solar panels as main fuel source for home lighting whilst the majority of the poor rural households are still dependent on traditional fuels sources such as kerosene, crop residues and others. The public policy implication of this research findings suggest the need to initiate social entrepreneurship and investment programs that will encourage solar photovoltaic uptake by poor and rural households who are still using traditional lighting fuel sources. However, further research is needed to understand drastic changes in the household energy use patterns over time using the current data and also to understand public acceptance and consumer perception of such renewable technology in Rwanda.



Source: Authors' computation based on 2013-2014 RIHLCS survey data
Fig.1. Home lighting energy sources (Rwandan rural households)

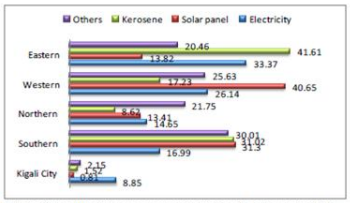


Fig 2. Distribution of Home lighting energy sources used by region (Rwandan rural households)

Descriptive statistics of solar photovoltaics and home lighting choice.jpg

Analysis of renewable energy contribution and energy use in university campuses for assessing the nearly zero-energy building gap

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 193

Dr. Marc Medrano [1], Dr. Lidia Rincón [1], Ms. Ariadna Carrobé [1], Dr. Albert Castell [1]

1. *University of Lleida*

Introduction

The European legislation has established ambitious targets for achieving high energy performances, with the aim for new buildings to reach nearly zero-energy use (NZEBs) by the end of 2020. Universities, playing an exemplary role in modern societies, should take the lead in analysing energy efficiency and proposing retrofit measures in their own buildings, targeting NZEB.

This study analyses 20 buildings of 4 campuses in the University of Lleida, in terms of building operational and geometric data, energy use, renewable production and current gap to NZEB targets.

Methods

The following steps have been applied: 1) compiling building data, renewable energy production and energy consumption; 2) performing overall and detailed analysis ; 3) assessing the actual gap between university building energy performance and Spanish NZEB goals.

Results and Discussion

Fig. 1 shows annual gas and electricity use per floor area. The two Health Sciences buildings E19 and E20 are highlighted as the major consumers. The rest of the buildings are in the range 50-175 kWh/m^2·year, comparable to the values reported by the UPC, which are between 40 and 200 kWh/m^2·year.

Fig. 2 shows the historical evolution of the annual renewable energy production in the two campuses with installed PV systems. Note that the two campuses have a decreasing trend in PV output production, with about 3% reduction per year. This efficiency drop per year is higher than the typical 1% drop given by many PV manufacturers and should be studied in more detail.

In Fig. 3 shows the calculated total primary energy consumption. The horizontal red lines correspond to the maximum threshold range. The buildings E2, E6, E12, E13, E15 and E18 have primary energy consumptions close to the maximum thresholds. Buildings E19 and E20 are very far from the NZEB concept. The non-HVAC services, such as specific labs, have a critical impact over the energy performance of these two buildings. The other 12 buildings have values around 2.5-3 times higher than the maximum thresholds, indicating that many improvements should be implemented to reduce this gap.

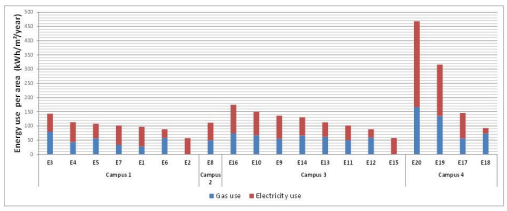


Fig. 1: Annual energy use per gross floor area in year 2016 for 20 buildings in four university campuses.

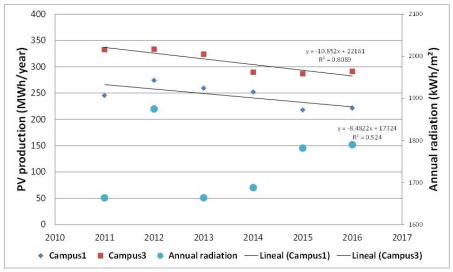


Fig. 2: Historical renewable energy production and solar radiation in the two campuses with PV systems.

Figura 1 icren 2018.jpg

Figura 2 icren 2018.jpg

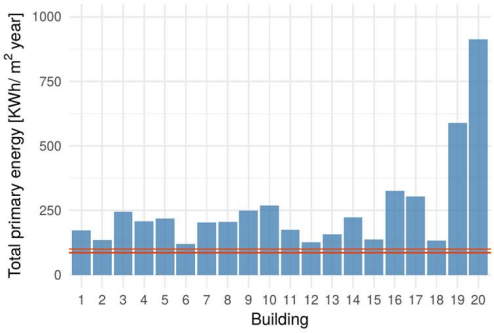


Fig. 3: Calculated total primary energy of each building. The red lines correspond to maximum thresholds estimated for the new Spanish building regulation.

Figura 3 icren 2018.jpg

Application of active and passive thermal solar systems for the processing of agricultural and agroindustrial products in the Northern Region of Costa Rica: a pilot local program

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 35

Dr. Guzmán Hernández Tomás de Jesús [1], ***Dr. Araya Rodriguez Fereddy*** [1], ***Dr. Obando Ulloa Javier*** [1], ***Prof. Castro Badilla Guillermo*** [1], ***Dr. Moreira Segura Cristian*** [1]

1. *Technological Institute from Costa Rica*

Drying, dehydration, sterilization and pasteurization are activities that are used for the processing and storing of food and other agricultural and agroindustrial products. In these processes different sources of energy are applied: electricity, fossil energy, wood and others. With the support of the local Pilot Program of Solar Energy Use in Northern Region of Costa Rica (executed jointly by the Technological Institute of Costa Rica and the Ministry of Agriculture) several solar thermal systems have been designed, applied and evaluated, at the level of small and medium producers in the area. Different production processes, substituting traditional options, for solar options and clean production systems, seeking to lower the local carbon footprint and improve production systems were included.

Several types of solar thermal systems have been designed and evaluated, namely: hybrid thermosiphons with electric auxiliary system, to sterilize milking equipment; forced hybrids with water and LP gas to sterilize and pasteurize milk, forced hybrids with water, hot air and LP gas, to be used to dry and dehydrate agricultural and agroindustrial products and a passive solar dryer for different types of seeds. The basic designed prototypes are shown, located in the Northen Region of Costa Rica.

The evaluations of the thermal systems were carried out through the use and testing of the different processes with satisfactory results. Among these processes it is possible to metion: milking equipment sterilization, pasteurization of milk, drying and dehydration of several products among them, pineapple, pumpkin, turmeric, ginger, coffee, cocoa, beans and corn. Information on the operation of the systems was obtained through a computerized data system and the location of thermocouples in the key locations of the systems used and their location in the cloud in order to download the data from any electronic device.

Keywords: Solar thermal systems for agricultural and agro-industrial processes

Img 4718.jpg

Img 4616.jpg

Img 4635.jpg

Redox stability of Sc-doped La0.6Sr0.4FeO3-δ for tubular solid oxide cells interconnector

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 12

Dr. Sun-dong Kim [1], ***Dr. Tae Woo Kim*** [1], ***Dr. Hyun-jong Choi*** [1], ***Mr. Minjoon Kwak*** [1], ***Mr. Doo-won Seo*** [1], ***Dr. Sang-kuk Woo*** [1]

1. *Korea Institute of Energy Research*

Ceramic interconnectors of tubular solid oxide cells should require fundamental properties as follow, because they are facing on both a reducing and oxidizing atmosphere at anodes and cathodes. Firstly, they should separate different gas atmospheres of an anode (inside) and a cathode (outside) by a dense layer with high chemical and redox stability, because the ceramic interconnectors are placed on between an anode of one individual cell to the cathode of the neighboring cell in a stack. Secondly, pure and high electronic conduction are one of the key properties to get a high performance by minimizing ohmic loss of the multi-layer stacking structure. With the objective of introducing a redox stable ceramic interconnector, the optimum concentration in $La_{0.6}Sr_{0.4}Fe_{1-x}Sc_xO_{3-\delta}$ (LSFSc) has been determined by analyzing the variation of composition, pH, synthetic temperature and heat treatment time.

The synthesis of $La_{0.6}Sr_{0.4}Fe_{1-x}Sc_xO_{3-\delta}$ (x=0.01, 0.05, 0.1, 0.2 and 0.3) powders follow a Pechini type polymerizerlable complex method. The effect of solution pH on the crystalline phase and stability of LSFSc was evaluated by adjusting the pH of the solution from pH 2 to pH 9 with ammonia water. The powder were calcinated at 900 and 1200 °C for 2, 6, and 24 h to eliminate the organic residual and to investigate the effect of the heat-treatment on the redox stability of the LSFSc crystalline phase.

The crystalline phases of LSFSc are stable when the solution pH is low (pH=2), and the calcination temperature is sufficiently high (T≥1200°C). From the XPS analysis, it is recognized that the incorporation of Sc in the LSF lattice makes its structural stability even more stable under the reduction condition. The phase stability of $La_{0.6}Sr_{0.4}Fe_{1-x}Sc_xO_{3-\delta}$ was obtained when the Sc concentration was over 10 mol%. Therefore, as depicted in figure below, $La_{0.6}Sr_{0.4}Fe_{0.9}Sc_{0.1}O_{3-\delta}$ is considered to be the most stable composition for a redox stable and electrically conductive ceramic interconnector for tubular solid oxide cells.

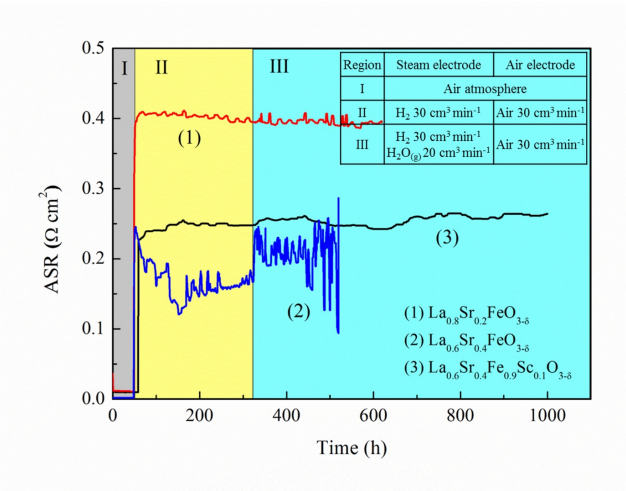


Figure.jpg

Thermal Performance Comparison of a Novel Chevron Collector and Standard Collectors

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 142

Dr. Farayi Musharavati [1], ***Mr. Rahib Khan*** [1]

1. *Qatar University*

Quantitative comparison of collector designs plays an important role in the development of solar thermal systems. In this paper, performance comparison of a novel chevron flat plate collector design against two collectors is presented. For the tested design, the chevron pattern was on the upper plate of the absorber while the lower plate was a flat aluminum channel. The aim of the investigation was to compare analyze the thermal performance of various collector designs and determine their suitability for solar seawater desalination systems for implementations in Qatar. For the purpose of comparison, two other collectors, i.e. a commercial collector, and a mosaic multichannel collector, were also investigated. The objective was to investigate the behavior of the thermal energy conversion system when the collectors of same size are connected to the same storage system and tested under similar environmental conditions. Outdoor experiments that include measurements of radiation, flow rates, temperatures and wind speeds were carried out. Preliminary investigations focused on the amount of heat collected in the storage system, charge and discharge modes of the system and the influence of load profiles. Satisfactory performances was observed for a morning and evening load draw-off operating mode with a direct stratified thermal storage system. The highest water temperatures obtained were 52°C, 55°C, and 65.5°C for the commercial, mosaic multichannel, and chevron collectors respectively. These results show the superiority of the chevron design. Since the minimum temperatures required for desalination is about 80°C, it can be inferred that the experimental collectors don not provide sufficiently heated water temperatures for effective solar desalination. However, it was noticed during the experiments that changing the arrangement of the chevron collector absorber (e.g. chevron patterns on the upper and lower plates with symmetrical and asymmetrical geometries) has a significant effect on the water flow behavior. Hence, an optimal flow pattern may provide improved collector performance to reach maximum water temperatures suitable for desalination.

Acknowledgements

This research was made possible by a NPRP award NPRP 5-161-2-053 from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the authors.

Electric vehicle adoption is influenced by governmental incentives? A Romanian study case.

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 304

Dr. Anca Constantinescu [1], ***Prof. Claudia Martis*** [2], ***Dr. Dorothee Ruck*** [3]

1. *Technical University of Cluj-NApoca,* ***2.*** *Technical University Cluj-Napoca,* ***3.*** *DLR*

During the last decade, electric vehicle market is continuously growing and can be a solution to environmental pollution problems. However, consumers adoption of an electric vehicle is relatively low in spite of many promotion policies implemented by governments.
In Romania, the European Strategy 2020 will sustain the continuing boost of the market, by setting 20% reduction in gas emissions (or even 30% under favorable conditions) comparing with the levels recorded in 1990. Therefore, "green" and hybrid cars reached 2.0% of the total sales, double the share they had in 2016,

*The present article aims at identifying the main policy that support the electric vehicles adoption within Europeans countries by emphasizing on the Romanian strategy for electric transportation and its efficiency. There are a lot of studies which find or not these incentives effective, therefore an o***verview of policy attributes in Europe it will be done.***Another goal of the present article is to assess and find the place of Romania into the already formed grouped of European countries, based upon the share of new sales.*
Methods – the secondary data will be computed and correlation between sales and incentives will be analyzed. We use Pearson correlation to find over different time series if there is any correlation between variables. The sample consist in at least one of European country from the five-strategic group from the positioning map.
The results display that in Romania there is a strong correlation between electric vehicle sales and governmental incentives. The analyses is distinctly provided for purchase subsidies (such as purchase-related tax exemptions or reductions, registration tax, import tax, co-funding or other financial purchase support), ownership benefits (annual tax exemption, reduction of electricity or energy costs) and local incentives (free parking, access to bus lanes, no toll fees, free charging, access to restricted areas in city centers). The demand for the most accessible electric car in Romania is higher (as percentage of total electric car sales) than in more developed countries.
In conclusion, Europe experienced an increasing demand for electric vehicles but the incentives are not the only variable influencing the adoption.

Artificial SAP and biofuels production

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 221

Prof. Arturo Solis Herrera [1]

1. *Human Photosynthesis(TM) Research Center*

Introduction

Unprecedented population growth, increasing conflict and displacement, natural calamities and emergence of major epidemics are some of the factors that will compound complexities of global food security over the coming years.

The next global food crisis is predicted to occur within four years by experts at the recent Third International Conference on Global Warming and Food Security.

Methods

In the face of these facts, any technique that can improve food production would be a welcome development. To counteract the coming problem, it is imperative to try novel and daring solutions across the agricultural food chain.

Replicating the processes of nature through which the food chain is integrated remains a formidable challenge. It seems simple to combine CO_2 and water to form carbohydrates and other useful molecules for nutrition such as amino acids, and lipids, as plants do it every day.

Results

We found a novel technique to manipulate photosynthesis to produce more food arising from $CO_2$and water. A product with natural SAP characteristics is obtained.

The product we currently obtain is comparable to artificial sap, and each 100 ml 0.47 g of proteins, lipids (unsaturated) 0.70 g, carbohydrates 5.43 g; Sodium 12.81 mg, Calcium 313.72 mg, Iron 18.75 mg. Every 100 ml of Artificial SAP® provides 29.90 kcal.

Discussion

Our discovery of the intrinsic property of melanin to dissociate the water molecule represents a watershed in the problem of food production, since it allows to produce nutritious substances in the laboratory in an efficient and practical way. Avoiding the use of pesticides, herbicides, fertilizers, waste water, and does not require the use of large tracts of land.

Artificial sap can be used for human and animal feed, or biofuel production, without competing with human food. The manufacturing process is patented in Russia and Canada, pending in other countries.

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Viales savia aug 2017.jpg

Información Nutrimental	Por 100 mL	
Contenido energético kJ (kcal)	kJ: 126.20 (kcal 29.90)	Por 125 ml: 37 kcal
Proteinas	0.47 g	
Grasas (Lipidos)	0.70 g	
Grasas saturadas	0.00	
Carbohidratos (Hidratos de carbono)	5.43 g	
Azúcares	0.00	
Fibra dietética	0.00	
Sodio	12.81 mg	
Calcio	313.72 mg	35 % VNR (100 ml)
Hierro	18.75 mg	110 % VNR (100 ml)

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Metabolic modelling of the effects of CO2 on mixotrophic microalgal cultivation

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 257

Mr. Anshu Dutta [1], ***Prof. Subhabrata Ray*** [1], ***Prof. Gargi Das*** [1], ***Prof. Saikat Chakraborty*** [1]

1. *Indian Institute of Technology Kharagpur*

Microalgae have great potential for bio-sequestration of CO_2 into macromolecules such as lipids and carbohydrates for the production of biodiesel and bioethanol, respectively. The primary metabolic step involves the conversion of RuBP to GAP through the Calvin Cycle in the presence of RuBisCO enzyme. Alternatively, photorespiration adds O_2 to RuBP, producing 3-PGI. Both steps require $O_2$and the synthesis of ATP, NADPH via coupled light reactions in the chloroplast. GAP converts to lipids via glycolysis and the TCA Cycle, and/or to carbohydrates through G6P via Gluconeogenesis. G6P also enters the Pentose Phosphate pathway yielding NADPH and Ru5P, which produce protein precursor nucleotides.

This metabolic modelling attempts to quantify the effects of CO_2, O_2 and nutrient supply at the reactor scale on the molecular scale reactions and the metabolic pathways for macromolecule synthesis that determines carbohydrate and lipid yields in mixotrophic cultivation of microalgae.

Our metabolic model is validated using experimental data on the concentrations of algal biomass, chlorophyll, lipids, carbohydrates, proteins, and dissolved CO_2 and O_2, available in the existing literature. This model attempts to integrate molecular pathways to reactor variables, and quantify their coupled effects on lipid and carbohydrate yields in mixotrophic algal cultivation.

The effects of hydrogen gas on gas network materials within a CO2 reduction energy trial

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 276

Dr. Shelley Brace [1], ***Dr. Richard Darton*** [1], ***Dr. John Staniforth*** [1]

1. *Keele University*

Introduction: The UK government has committed to an ambitious target of an 80 % reduction in CO2 emissions by 2050 (from 1990 levels). As the provision of heat makes up almost 50% of UK energy consumption mainly provided by gas, the decarbonisation of heat is a key requirement in meeting the CO2 emissions targets.

The inclusion of injected hydrogen up to 20% v/v presents a potential route to decarbonise the gas system whereby previous studies have shown that existing appliances can operate safely at this level of hydrogen. In preparation for a 1-year live trial on Keele University's gas network, this project investigates the likelihood of adverse affects on gas network materials.

Method: In order to determine whether adverse affects on network materials are likely to occur within or after the trial of up to 20% hydrogen addition, various materials identified within the gas network have been soaked in 100% hydrogen gas for up to 9 weeks. Stainless steel, copper, and brass, powders and specimens have been subsequently studied by thermal desorption to determine their hydrogen gas susceptibility.

R&D: Grade 304 stainless steel powder was soaked in 100% hydrogen gas for up to 9 weeks. Due to the increased surface area of powdered materials compared to specimens, it is possible to determine longer term hydrogen gas susceptibility from a short term study. Despite being generally understood that steel suffers from hydrogen embrittlement, the 9 weeks hydrogen gas soaking showed no hydrogen gas susceptibility (Figure 1). This result was also found for copper powder (Figure 2).

Stainless steel rod however is closer to the network conditions and indicated a small increase in hydrogen desorption for longer hydrogen gas soaking times. It is unclear if this is sufficient to affect the mechanical performance of 304 steel.

The hydrogen gas susceptibility of brass (70/30) powder soaked in 100% hydrogen gas for up to 9 weeks (Figure 3) shows a trend of increasing hydrogen gas desorption for longer soaking times. This effect is also exaggerated at higher temperatures (not shown) and will be taken into account within the parameters of the trial.

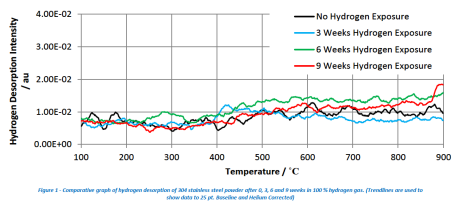


Figure 1 - tpd of stainless steel 304 powder.png

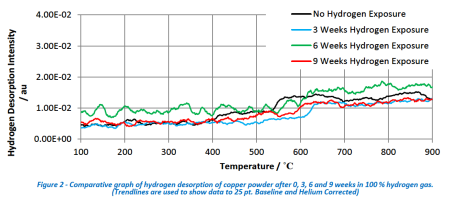


Figure 2 - tpd of copper powder.png

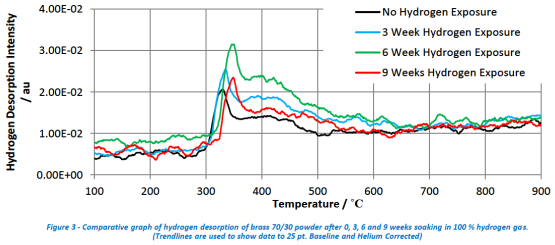


Figure 3 - tpd of brass 70-30 powder.png

Solar heat power engine on the basic of direct convertion of the Planck spectrum of solar radiation with the use graphene nanofluids

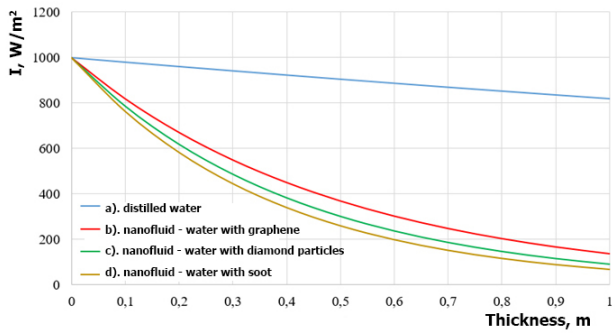
Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 312

Prof. Alex Dmitriev [1]

1. *National Research University "MPEI", Russia*

Modern solar energy is based on photoelectric conversion using semiconductors. For the conversion of solar radiation, only parts of the solar radiation spectrum are used in this way. The main part of such radiation (Planck spectrum) can not be used, since it is not absorbed and not transformed by available methods. However, if using nanofluids, for example, based on graphene flakes or nanotubes, it is possible, due to the strong absorption of the thermal spectrum of solar radiation, to effectively heat the working fluids to the formation temperature of steam. The results of experimental studies of such heating with the use of a solar radiation imitator are demonstrated, calculations of the absorption of radiation and heating of working fluids with very high efficiency are made. Conclusions are made about the possibility of creating new solar thermal power plants based on direct conversion of solar radiation from the whole Planck spectrum to steam. The possibility of using nanofluids as a coolant in solar concentrators was considered. In such solar thermal conversion system, special absorbers are used to absorb solar radiation, with a large absorption coefficient, which heats up giving off heat to the heat carrier, the absorber is used as in the coolant. In our work, we studied various nanofluids, for example, graphene nanocolloids and nanodiamond colloids. When using a nanofluid (carbon nanocolloids), the basic idea is to avoid absorbing solar radiation on the channel walls, since the nanofluids themselves have a high absorbing capacity, in this case there will be bulk absorption of nanoparticles. To achieve this goal, we first of all measured the absorption coefficients, the transmittance of nanofluids, but, in addition, other important measurements and calculations were made: 1). the absorption and transmission coefficients of nanofluids were measured and compared with distilled water, 2). according to the Bouguer-Lambert-Beer law, the intensity of the transmitted solar radiation was calculated through a layer of nanofluid, 3). the effect of nanoparticles on liquid heating has been studied, 4). the viscosity of the nanofluid is calculated.

This work was supported by the Russian Science Foundation (project No. 17-19-01757).



19.jpg

Accelerating Renewable Energy Investment: The Role of International Investment Law

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 412

Mr. Martin Svec [1]

1. *Masaryk University*

The world community has acknowledged that climate change represents an urgent and potentially irreversible threat to human societies and the planet. At the UN Climate Conference in Pairs, 195 countries adopted the first-ever universal, legally binding global climate deal to strengthen the global response to the threat of climate change. The central objective of the Paris Agreement is to hold global average temperature increase to “well below 2°C above pre-industrial levels”. However, this ambitious goal will require accelerated deployment of modern renewables and energy efficiency measures.

Although global investments in renewables have shown steady growth for more than a decade, they are not consistent with the goal of limiting global rise in temperature to less than 2°C set by the Paris Agreement (IEA, IRENA). Significant deployment of additional private investments is required. For instance, the International Energy Agency estimates that the implementation of the climate pledges in the Paris Agreement will require $13.5tn investments in energy efficiency and low-carbon technologies from 2015 to 2030.

In this context, international investment law can play a major role in the implementation of the Paris Agreement, since it provides investors with both substantive guarantees and investors-state dispute resolution mechanism. Predictable and stable regulatory framework as well as remedies against host states for a breach of rule of law are essential for swift deployment of renewables. This poster analyses the sources of international investment law, particularly bilateral investment treaties, investment chapters of free trade agreements (such as NAFTA, CETA) and regional treaties (such as the Energy Charter Treaty).

Against the backdrop of recent developments in international investment law (termination of intra-EU BITs, the *Achmea* judgment of the Court of Justice of the European Union, renewable energy arbitrations under BITs and the ECT in Europe), the poster analyses the role of international investment law in the implementation of the Paris Agreement with a special focus on renewable energy investment.

Fully scalable HTM-free hybrid perovskite solar cells with carbon electrode

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 172

Ms. Sonya Kosar [1]***, Dr. Longbin Qiu*** [1]***, Dr. Yan Jiang*** [1]***, Dr. Luis K. Ono*** [1]***, Dr. Yabing Qi*** [1]

1. *Okinawa Institute of Science and Technology Graduate University (OIST)*

Sonya Kosar, Longbin Qiu, Yan Jiang, Luis K. Ono and Yabing Qi [*]

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The organic-inorganic perovskite solar cells showed tremendous increase in efficiency during the recent decade, starting from 3.8%[1] and already saturating at 22%[2]. The matter of further work is to make the device stable, scalable and inexpensive. Thus, much effort is being put into development of commercially more attractive perovskite solar cells without expensive hole transporting material with carbon top electrode instead of Au one. Additionally, despite common belief the applicability of solvent-assisted methods for the large-scale manufacturing of hybrid perovskite modules is still under debate. Thus, in this work, we demonstrate a combination of vacuum techniques for device preparation with inexpensive carbon counter electrode as a concept towards large scale fabrication of inexpensive perovskite solar cells.

We offer to use hybrid chemical vapor deposition (HCVD) method[3] to prepare high quality perovskite films and carbon paste as efficient hole-collecting electrode (the device structure is presented on Fig. 1a). The HCVD method allows successful diffusion of CH_3NH_3I vapor into thermally evaporated PbI_2 layer forming homogeneous $CH_3NH_3PbI_3$ film with large grains and smooth grain boundaries (Fig. 1b), which is beneficial for charge transfer.

Our best device shows efficiency of ~5% with V_{oc} of 0.93 V, J_{sc} of 12.4 mA/cm^2 and fill factor of 0.42 (Fig. 1c). We believe that modification of carbon paste properties, e.g. increase of work function, is the key step towards further enhancing of power conversion efficiency.

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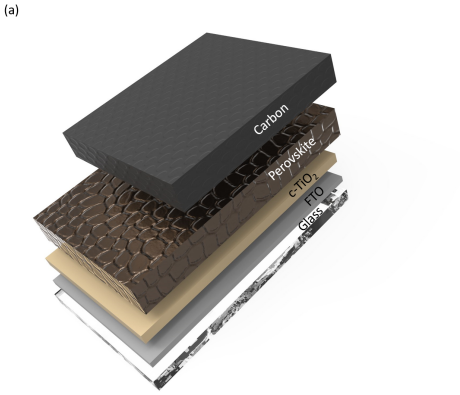


Fig.1. a device structure of htm-free perovskite solar cell with carbon electrode.png

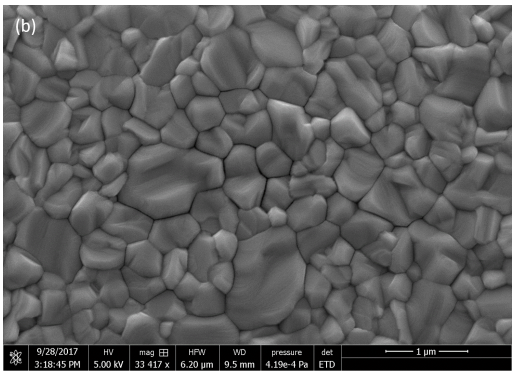


Fig.1. b sem image of perovskite film.png

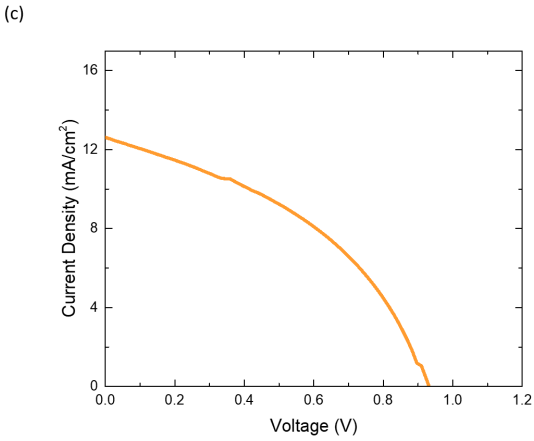


Fig.1. c j-v curve for the best device showing 5 pce.png

The reflection-enhanced lumpy silver particles applied in thin film amorphous silicon solar cel

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 90

Prof. dongsheng li [1], ***Prof. Yong Jun WU*** [1]

1. *State Key Laboratory of Silicon Materials and School of Materials Science and Engineering, Zhejiang University*

A tailored large-size plasmonic core-protuberances silver particle with unique optical properties with promising applications in thin-film solar cells was numerically and experimentally studied. The designed particle possesses an extremely enhanced electromagnetic near-field excited by localized surface plasmons resonance and its far field angular plots of light scattering power indicated an enhanced back-scattering ability. When embedded the lumpy particles into the rear of thin-film amorphous silicon solar cells, light trapping in broad wavelength range and ideal short circuit density of the cells increased.

High performance p-type half-Heusler thermoelectric materials

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 71

Prof. Tiejun Zhu [1]

1. *Zhejiang University*

Half-Heusler (HH) compounds are important high temperature thermoelectric (TE) materials having attracted considerable attention in the recent years. High figure of meritzT values of 0.8~1.0 have been obtained in n-type ZrNiSn based HH compounds. However, developing high performance p-type HH compounds with low cost is a big challenge. we show a high zT of 1.1 at 1100K can be achieved for p-type $FeNb_{1-x}Ti_xSb$ HH alloys and the Hf doped FeNbSb exhibits a record high zT of 1.5 at 1200K due to simultaneously optimized electrical power factors and reduced lattice thermal conductivity. In view of abundantly available elements, good stability and high zT, $FeNb_{1-x}Ti_xSb$ alloys can be great promising for high temperature power generation.

Batt//Gen: A self-recharging device

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 154

Prof. Arturo Solis Herrera [1], ***Dr. Maria Del Carmen Arias Esparza*** [1]

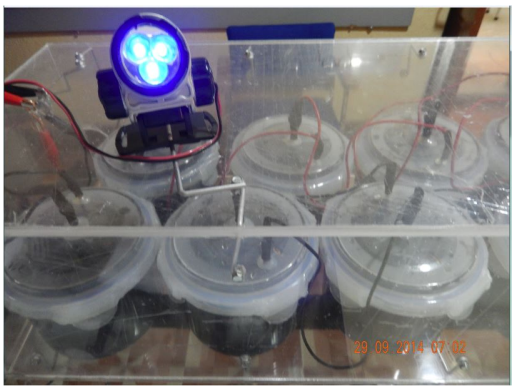
1. *Human Photosynthesis(TM) Research Center*

The search for new sustainable energy sources seems to have come to an end with the discovery of Human Photosynthesis ® in the year 2002. The finding that not only plants but all living beings are able to capture energy from light and concatenate it to drive the biochemical processes that make up them, opens a new era in different areas of human knowledge, such as biology, medicine, energy, ecology, food production; etc.

To date, it was a deeply rooted dogma that only plants can transform light energy into chemical energy by dissociating the water molecule. But, during an observational, descriptive study, about the morphological characteristics of the tiny blood vessels of the optic nerve and its relationship with the three main causes of blindness-Glaucoma, Diabetes, Macular degeneration related to the Age-we were able to identify a molecule in the human eye, which, in the presence of light and water, generates energy for centuries.

The mode of action of this molecule is like chlorophyll as it transforms light into chemical energy through the dissociation of the water molecule, although it is thousands of times more efficient than it, as the chlorophyll only absorbs the ends of the visible spectrum (Violet and red), while melanin can absorb the entire electromagnetic spectrum, from radio waves to gamma rays.

Melanin is the most stable substance known, as it has been found in good condition the ink sacks of fossilized squid that died 170 million years ago. It is therefore to be expected that melanin-based designs can generate energy for thousands or millions of years.



Batt gen 2.jpg

Batt gen.jpg

Bat gen mayo 2016.png

Hydrothermal synthesis of hematite nanostructures for photocatalytic applications

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 226

Mr. Emre Alp [1], Mr. Umut Savacı [2], Mr. Burak Tekin [3], Mr. Halil Eşgin [4], Prof. Savaş Sönmezoğlu [5], Prof. Servet Turan [2], Dr. Aziz Genç [1]

1. *Department of Metallurgical and Materials Engineering, Bartın University,* ***2.*** *Department of Materials Science and Engineering, Anadolu University,* ***3.*** *Nanotechnology R&D Laboratory, Karamanoğlu Mehmetbey University,* ***4.*** *Central Research Laboratory, Bartın University,* ***5.*** *Nanotechnology R&D Laboratory & Department of Metallurgical and Materials Engineering, Karamanoğlu Mehmetbey University*

In this study, hematite (α-F2O3) nanostructures with porous plate and pseudo-cubic are fabricated via hydrothermal synthesis at 200 ^{o}C for 12 h. Microstructural and phase characterization of the snyhtesized hematite nanostructures are conducted via X-ray diffraction (XRD), scanning electron microscopy (SEM) and high resolution transmission electron microscopy (HRTEM) techniques. We have used pre-synthesized CuO nanorods for the synthesis and by modifying the surface of the sacrificial CuO nanostructures with polyvinylpyrrolidone (PVP), we could tune the morphology of the hematite from pseudo-nanocubes to porous plates. Photocatalytic activity of the samples are tested for the photodegradation of Rhodamine B under AM 1.5 filtered light. Water splitting performance of the samples are also tested by using a photoelectrochemical system.
Figure 1. SEM and TEM images of the porous nanoplates.
Figure 2. SEM and TEM images of the pseudo-nanocubes.

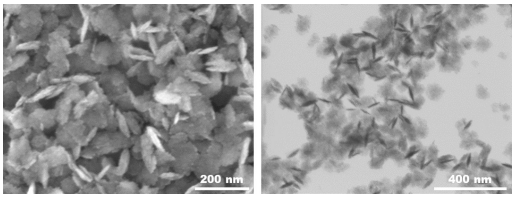


Figure 1.jpg

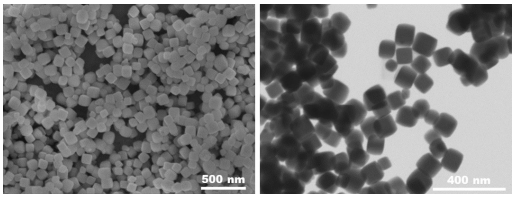


Figure 2.jpg

A New Class of Water-Borne Nanoparticles with Unusal p-n Heterostructure for Superior Charge Separation Property

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 63

Dr. Yu Jin Kim [1]

1. *Argonne National Laboratory*

Eco-friendly synthesis of organic semiconductors with heterojunctions has been of interest, which requires surfactants to stabilize the colloidal nanoparticles (NPs) in aqueous solution. Use of conventional surfactants results in the p-n heterostructured NPs, where both p- and n-type semiconductors are phase-separated and confined within a core surrounded by the surfactant shell. Their device performances however have not been comparable to solid organic semiconductor films. Further efforts are required to understand and control the morphological structure of the nanoparticles and thus improve their performances. Here, using a new class of surfactant, PEG-C60, we synthesized a unique p-n heterostructured water-borne NP that comprises of p-type semiconductor as a core and n-type PEG-C60 as a shell. We demonstrate that the morphology allows superior charge separation over conventional water-borne NPs. These PEG-C60-based water-borne NPs, thus, can open up and provide a new paradigm in the current fields of water-based organic semiconductor colloids.

MOF−derived binder-free carbon–metal oxides composite electrodes for electrochemical devices

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 252

Mr. Xuan Zhang [1], ***Prof. Jiangshui Luo*** [1], ***Mr. Kai Wan*** [1], ***Mr. Pengyi Tang*** [2], ***Prof. Jordi Arbiol*** [2], ***Prof. Jan Fransaer*** [1]

1. *KU Leuven,* ***2.*** *Catalan Institute of Nanoscience and Nanotechnology (ICN2)*

Carbon-metal oxide composite materials have been widely used in electrochemical devices, such as supercapacitors, sensors, lithium-ion batteries and fuel cells. Despite the significant advances in preparing carbon-metal oxide composite electrodes, methods for seamless interconnecting of these two materials are still scarce. In this work,we introduce a novel method for the *in situ* synthesis of porous carbon–metal oxide composite porous electrodes. Firstly, metal-organic frameworks (MOFs) are deposited directly on porous substrates by anodic electrodeposition. Subsequent pyrolysis and activation lead to the formation of carbon–metal oxides composite electrodes. Several MOF derived electrodes have been prepared successfully *via* the same procedure, demonstrating the versatility of the proposed method. The resulting electrodes based on different MOFs show promising performance as supercapacitors and glucose sensors, respectively.

Study of Photovoltaic Cells Implantation in a Long-Endurance Airplane Drone.

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 303

Ms. Viviana Martinez [1], Dr. Vincent Boitier [2], Dr. François Defaÿ [1], Mr. Kolja Neuhaus [2], Dr. Michaël Bressan [2], Prof. Corinne Alonso [2]

1. ISAE-SUPAERO, 2. LAAS-CNRS

Applications of UAVs are expanding for long-endurance mission such as agricultural inspection, fire prevention and many others. Photovoltaic cells can be added to the wing surface and extend the global endurance of the UAV. This paper builds a model of the whole system and estimates the energy savings that can be achieved for different cell technologies and different types of missions. Furthermore, the impact of airplane movement (roll) on the performance of the maximum power point tracking control algorithm (MPPT) is studied.

Amount of energy offered by the photovoltaic chain

TABLE I ENERGY INTAKE

21 June time	<G> (W/m²)	AltaDevices	SunPower
14h00	1050	38%	27%
10h00	708	23%	18%
18h00	558	20%	14%

31 December time	<G> (W/m²)	AltaDevices	SunPower
14h00	325	11%	8%
10h00	230	8%	5%
18h00	0	0%	0%

Tab1.jpg

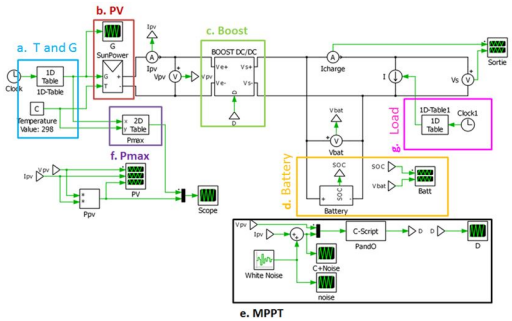


Fig. 4 Complete Plecs description of the energy chain (from sun to the load)

Fig4.jpg

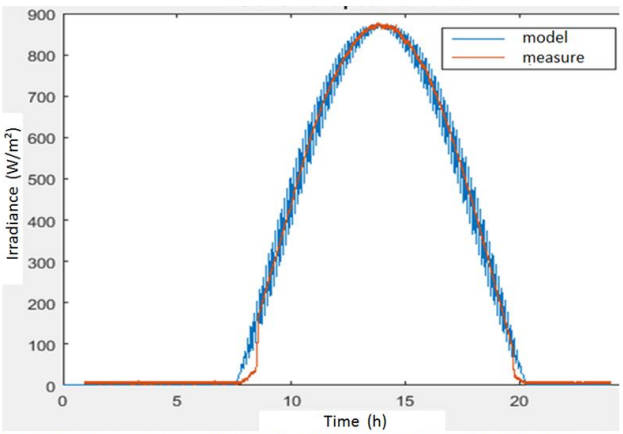


Fig. 2 Irradiation vs Time. Simulation with roll variation ± 5° (blue line) and measured irradiance (red line), profile on April 7th 2016, Toulouse.

Fig2.jpg

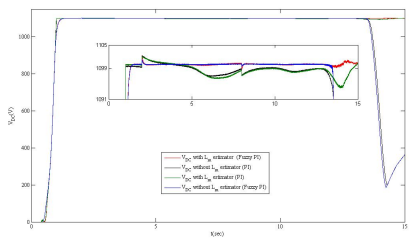
Fuzzy Controller for Self-Excited Dual Star Induction Generator with Online Estimation of Magnetizing Inductance Used in Wind Energy Conversion

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 293

Mr. Yacine Bendjeddou [1], ***Prof. Rachid Abdessemed*** [2], ***Dr. Elkheir Merabet*** [3]

1. *Ecole supérieure en génie électrique et énergétique d'Oran,* ***2.*** *Université Mustafa Benboulaid Batna-2,* ***3.*** *Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj*

This paper presents a novel direct rotor flux oriented control with online estimation of magnetizing current and magnetizing inductance applied to self-excited dual star induction generator equipping a wind turbine in remote sites. The induction generator is connected to nonlinear load trough two PWM rectifiers. The fuzzy logic controller is used to ensure the DC bus voltage a constant value when changes in speed and load conditions. In this study, a performance comparison between the conventional approach and the novel approach is made. The proposed control strategy is validated by simulation in Matlab/Simulink.



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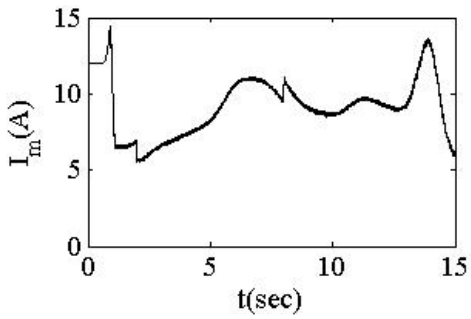

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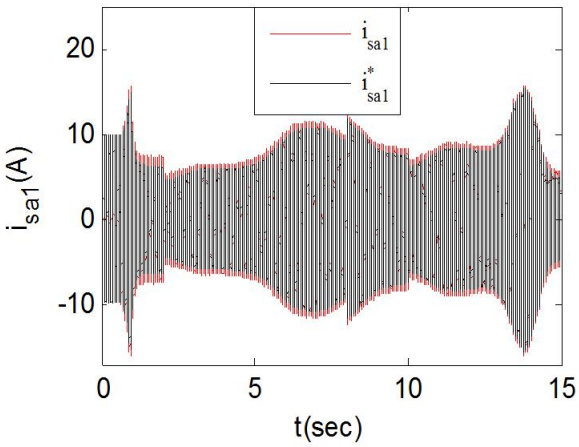


Image001.jpg

Feasibility Tests Of PV Module To Be Installed Beneath The Salt Farm

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 403

Dr. Cheolhyun lim [1], ***Dr. Changheon Kim*** [1], ***Dr. Sukho Lee*** [1], ***Mr. Seungmin Lee*** [2], ***Mr. Bongsuck Kim*** [2]

1. *Green energy institute,* ***2.*** *Korea electric power research*

From the point of view: the diversification of photovoltaic(PV) installation site, installing PV systems on water bodies like lake, reservoir, canal and salt farm has attracted a great deal of attention owing to gaining more electricity originated from the cooling effects by the water body. The concept of solar PV systems installed beneath salt farm is proposed for the first time in the world.

A salt farm adopting a solar evaporation method in Korea conventionally consists of two ponds, evaporation pond for increasing salinity and crystallization pond for harvesting salt. Water proof solar PV modules are installed in the beneath of shallow pond (2~15cm, depth), that is evaporation pond. The front part of modules is only submerged in the water, but the rear part of modules where a junction box is placed is not submerged. The gaps between modules are sealed with specially designed parts to prevent the leakage of sea waters.

The most merit of this system is able to harvest both salt and electricity at a same site and same time. The power generation would be decreased due to the installation angle, zero degree and the weakened solar incident intensity by sea water reflection. However, it is believed that the loss of power generation can be overcome partially by the cooling effect of sea water. We named this system 「Salt Farm Underwater Photovoltaic Systems」.

In this study, feasibility tests were conducted to confirm sea water effects on the performance of PV module. To do this, we fabricated water tanks where a single cell module of ~5W is installed at the bottom. The performance of module was examined by an AM 1.5 solar simulator with various temperature (20 ~ 60□) and depth (0 ~ 10 cm) of water. The effects of temperature and depth of water on the performance of PV module were confirmed. In additionally, the properties of single- and multi- crystalline silicon solar cell were comparison.

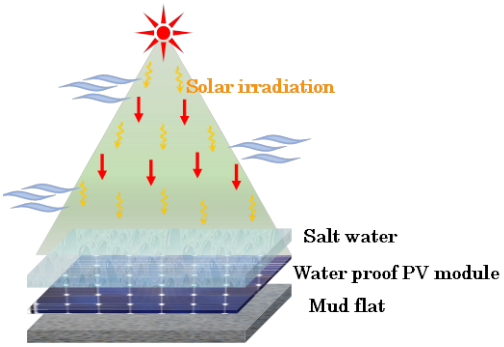


Fig1.png

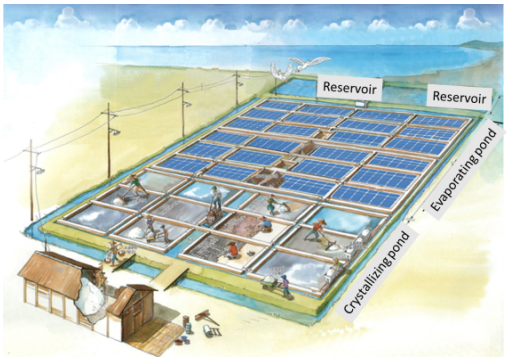


Fig2..png

On the thermal stratification of a solar hot water storage tank during discharging process

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 410

Dr. mohamed taher bouzaher [1], ***Dr. Lebbi Mohamed*** [1], ***Dr. Boualit Hamid*** [1], ***Dr. Chergui Toufik*** [1], ***Ms. Laouar Salima*** [1]

1. *Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algeria.*

The effects of different inlet forms on the thermal stratification and the performance of a hot water storage tank are considered in the present paper. Numerical analyses based on a two-dimensional (2D) and three dimensional (3D) unsteady Computational Fluid Dynamics (CFD) model were accomplished using the commercial software ANSYS-fluent. The comparison of the computation results with the available experimental data in the literature has showed a good agreement. Also a comparison between (2D) and (3D) results is provided.
The results indicated that an appropriate design could provide improved stratification conditions. It is seen that the configurations which are able to prevent the mixing process can provide better thermal stratification.

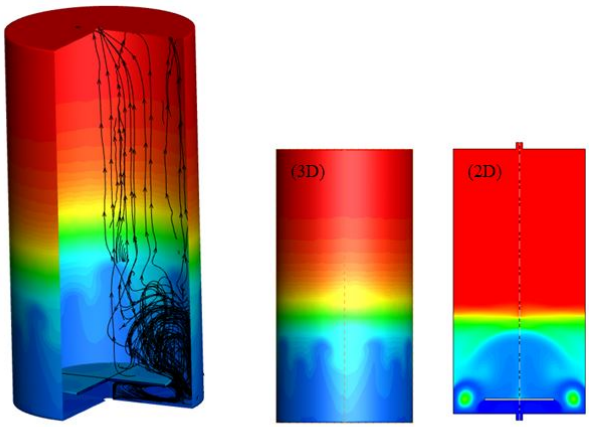


Fig 1 : Evolution of the temperature contours during the discharge process

Capture.jpg

Study of the thermal performances of an agricultural greenhouse doted with storage system

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 415

Dr. LALMI Djemoui [1]***, Dr. Hocine Bensaha*** [2]***, Mr. Abdelouahab Benseddik*** [2]***, Mr. Rida Zarrit*** [2]

1. *Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algeria,* ***2.*** *Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algeria.*

Tunnel-type plastic greenhouses are widely used around the world, especially in the countries of the Mediterranean Basin, because of their low investment cost.
These are efficient in winter and spring, where solar energy is useful and sufficient for greenhouse production. On the other hand, these greenhouses lose their effectiveness in summer where, the climate is very hot, which causes excessive overheating and strong hygrometries inside.
These extreme weather conditions affect the quality and quantity of the product and promote the development of certain diseases. On the physical plane, the greenhouse is a complex energy system in which all the different modes of thermal and mass exchange intervene. If they are relatively simple and well known, their coupling causes difficulties in the modeling of the system.
In this system, natural convection is a particularly important mechanism for heat exchange between indoor air and all other solid surfaces (floor, walls, roof, culture, air conditioning and heating systems).The aim objective of this work is study the storage system effects on thermal performance of an agricultural greenhouse in semi-arid climate case Ghardaïa.
The data climate are used for predict the energy needs as comparison with another without storage system.
The obtained results indicate that the outside needs are less than the no heated with 3 to 5°c during winter night. The thermal behavior of the greenhouse was study numerically and the results are corroborating with the literature.

Figure1. Geographic situation of Ghardaïa

Figure 2. The two greenhouse test facility in URAER

Algeria.jpg

The two greenhouses.jpg

Figure3. Storage system and its design steps

Storage system.jpg

Modeling of Hybrid Solar Panel for Producing the Hydrogen

Friday, 27th April - 13:30 - Poster Session - Gallery - Poster - Abstract ID: 445

Mr. Chawki Ameur menad [1], ***Prof. Rabah Gomri*** [2]

1. *Univesity Frère mentouri Constantine, 25000 Algeria,* ***2.*** *University Mentouri Constantine, 25000 Algeria*

Applied renewable energy for improving the quality of life has taken the major part of the modern research. The purpose of doing this research is developing new technology which is modeling a new hybrid solar panels generating by different sources of renewable energy, and mini mechanical systems. As a result generating hybrid solar panel by geothermal energy and solar energy, including the mini-turbine increases the water's temperature from 95°C to 622°C for producing the hydrogen through the electrochemical thermodynamic by using HTES Technology.

Feasibility approach of power generation from Solar Thermal Wind Tower: Inclusive impact assessment concerning environmental and economic costs

Friday, 27th April - 14:30 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 292

Mr. Islam Elsayed [1]***, Prof. Yoshiki Nishi*** [1]

1. *Yokohama National University*

PREFACE

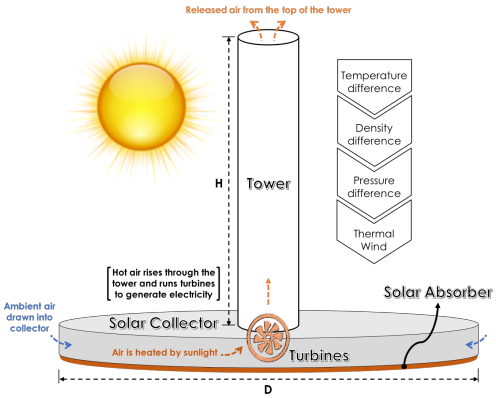
The Solar Thermal Wind Tower (STWT) mimics nature's wind cycle, utilizing a combination of flat plate solar air collector and central updraft tower to produce thermal wind which drives the turbines to generate electricity. In this research, we discussed both environmental impact and economic feasibility of different power generating capacities of STWT. Moreover, we discussed the ability and the negative environmental effect of having an offshore STWT as a novel technology. Both the environmental impact and the "triple I" index for STWT system are done for the first time in this research.

RESEARCH APPROACH

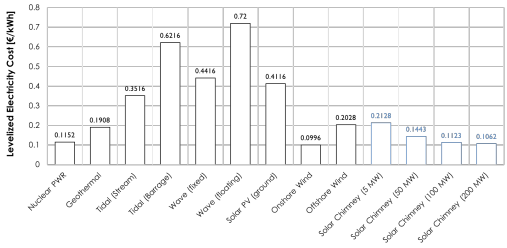
The calculations of the output power and the system efficiency have done on 4 different generating capacities, using the analytical model based on the typical dimensions from the past researchers. Environmental disadvantages aspect has been discussed by making CO_2 inventory analysis for the life-cycle of the system. Evaluation of economic feasibility for cost of electricity generation by each power generation capacity of STWT system, by calculating levelized electricity cost (LEC). Inclusive Impact Index (Triple I) estimates whether is good to do the project or not to do, a negative value of the index means this project is sustainable. We discussed the implementation and the potential of constructing offshore STWT.

CONCLUSION

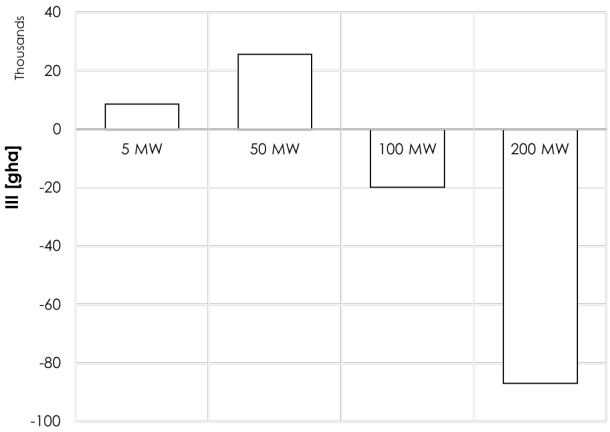
- Comparing with most of the power generation technologies, the system has low negative environmental impact. On the other hand, most of CO_2 emissions are exhausted in the manufacturing stage.
- LEC decreases with the increase of system scale, in short, by enlarging the capacity of the system, the system tends to be economical and feasible comparing with other low-carbon generation technologies.
- The "triple I" index of solar chimney system tends to have negative value by enlarging the capacity above 50 MW, thus, we can consider solar chimney systems a sustainable power generation technology.
- The negative environmental impact increases by offshore technology by about 25% for losing productive sea area, as a first ideation towards a future work of carrying out a feasibility studies on the offshore STWT structures, by the time we can go further and break through the potential of solar energy on the ocean.



System layout.png



Evaluation of economy.png



Iii for each generating capacity of stwt.png

Computational Fluid Dynamics Modelling and Performance Analysis of a Flat-Box Solar Thermal Collector with Multi-Channel Absorber

Friday, 27th April - 14:47 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 140

Dr. Farayi Musharavati [1], ***Dr. Khaled Ibrahim*** [1], ***Dr. Samer Gowid*** [1], ***Mr. Rahib Khan*** [1]

1. *Qatar University*

A novel multi-channel flat-box solar thermal collector was designed, constructed and tested. The collector was mounted on a 2-axis solar tracking system. An instantaneous efficiency curve for this collector was developed and collector parameters determined. Collector parameters were used to characterize the collector. A CFD model of the collector was developed. This model was used to investigate the significant influences of the mass flow rate, inlet water temperature, collector box dimensions and the effect of changing the flat-box materials. The efficiency of the multichannel collector was found to be 80.1%. The heat loss coefficient was found to be 4.0 W/m^2K. Comparison of experimental and model predicted data showed a close agreement with a 10.3% error. However, differences between experimental and model predicted data increase with time of day due to the collector restoring more energy and thus causing more radiation and convection losses than assumed in the CFD model. Four materials of the flat-box collector were tested. Test results showed small differences of the outlet temperature when different materials are used for construction. This indicates the relative importance of radiation in solar collectors in comparison to other heat transfer regimes. The lower flow rate exhibited higher output temperatures and the higher flow rate showed lower temperatures. The conductivity of the flat-box is crucial in heating up the water from all direction. From the obtained results, it can be inferred that the CFD model is able to simulate the solar collector with known sources of errors. Therefore, the CFD model is a useful tool that can be used to improve the design of flat plate solar collectors. The model can also be used to optimize the dimensions of the flat collector box for improved performance of the multichannel solar thermal collector. Collector performance demonstrate potential for solar thermal applications for water heating and desalination in Qatar.

Acknowledgement: This research was made possible by a NPRP award NPRP No. : 5 -161 – 2 - 053 from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the authors.

Figure 1 solar thermal collector.jpg

Figure 2 solar tracking system.jpg

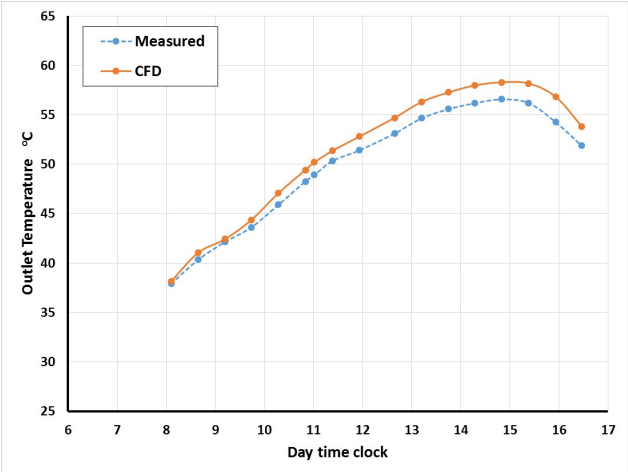


Figure 3 comparison of experimental and cfd data on water temperatures at the outlet point during a full day data collection.jpg

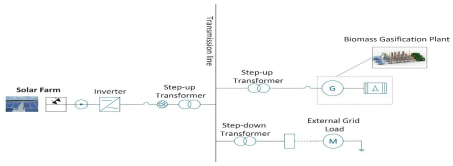
Hybrid Renewable Energy Systems for Generation of Own Power by Small and Medium-Scale Enterprises

Friday, 27th April - 15:04 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 332

Mr. Archishman Bose [1], ***Mr. Tommaso Mura*** [2], ***Mr. Kiran Rajan*** [3], ***Mr. Jialei Xin*** [3], ***Ms. Denitsa Kuzeva*** [4], ***Dr. Jeevan Jayasuriya*** [5]

1. *InnoEnergy Master School: MSc. SELECT - KTH Royal Institute of Technology/ Politecnico di Torino,* ***2.*** *InnoEnergy Master School: MSc. SELECT - Universitat Politècnica de Catalunya, Barcelona/ Instituto Superior Técnico, Lisbon,* ***3.*** *InnoEnergy Master School: MSc. SELECT - KTH Royal Institute of Technology/ Eindhoven University of Technology,* ***4.*** *InnoEnergy Master School: MSc. SELECT - Universitat Politècnica de Catalunya, Barcelona/ Eindhoven University of Technology,* ***5.*** *InnoEnergy Scandinavia*

Decentralized power generation, from renewables, is an attractive option for the future energy transition. In this paper, techno-economic potential to produce own power from distributed renewable to de-carbonize the operations of the Small and Medium Scale Enterprises (SMEs) was critically analyzed, together with socio-political aspects, based on a case study. As a representative of a SME, one of the leading printing outfits of Sri Lanka was selected. Solar photovoltaic (PV) and biomass gasification systems were identified as the most cost-efficient and easy to operate technologies for grid connected, decentralized, small-scale power generation at present. Grid integration would severely limit the economic viability of small scale power generation units, irrespective of the technology. The local availability of both resource and technology are crucial for financial success of such projects. Low capacity factor of solar PV and complexity of the supply chain for biomass to power systems are critical factors for system sizing and operation of stand-alone small-scale applications of respective technologies. Utilization of wastes for energy generation of the associated industry would, nevertheless, improve economic benefits to the biomass system and stabilize the supply chain of biomass feedstock. A hybrid Solar PV-Biomass gasification power generation system, however, would have superior techno-economic performances with lower environment impact than stand-alone systems. Complementing plant capacity factors of PV and biomass systems, coupled with high part load efficiency of internal combustion engine-based power generation from biomass gasification would provide a more stable power output from the hybrid system, even with the presence of a fluctuating renewable like solar. Possibilities for such systems to perform ancillary services were thus explored in brief. An equal share of the net power capacity between the technologies was obtained as the most suitable combination for a small-scale Solar PV-Biomass gasification hybrid power system. A net carbon dioxide reduction of more than eighty percent of the operations of the SMEs is feasible depending on individual country's grid emission factors. Socio-political factors have a high impact on overall viability of small-scale systems, leading to risks for project viability of ill-designed systems.

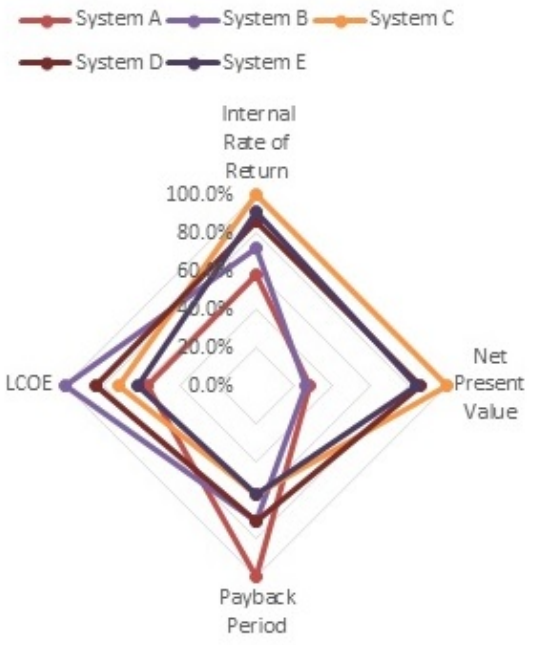


Hybridization.jpg

Systems considered for techno-economic comparative evaluations to supply 5.2 GWh_{el} per year

	Equivalent System Capacities (MW)	
Technology	Solar PV	Biomass Gasification
System A	3	-
System B	-	1
System C	1	1
System D	0.5	1.5
System E	2	0.5

Hybrid sizes.jpg



Economic performance comparison.jpg

Influence of PV power generation on energy consumption in domestic buildings in Saudi Arabia

Friday, 27th April - 15:21 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 283

Dr. Abdulsalam Alghamdi [1]

1. *King Abdulaziz University*

Due to its geographical location, the Kingdom of Saudi Arabia (KSA) is blessed with huge solar resources. Through its Vision 2030, the Government has set up a target of installing 9.5 GW of renewable energy systems by 2030. This is planned to be delivered though mixed wind energy and solar energy technologies. For solar energy alone, the government has recently announced plans to invest around US$109 billion over the next 20 years. Most of this deployment will be large-scale solar photovoltaic and concentrated solar (solar thermal). Most conducted studies predominantly focus on large-scale solar PV potentials in Saudi Arabia and do not address the possibility of installing PV on domestic rooftops and how the power generated impacts energy consumption in such buildings. This is the subject of this paper.

At present, the domestic electricity demand is almost 100% dependant on generation using fossil fuels, and as indicated earlier KSA has natural resources that can be exploited to support sustainability and improve energy security. This work presents both consumption data of two typical buildings in KSA linked to both TRANSYS thermal simulation of the buildings as well as energy yields from appropriately designed PV arrays on the roofs of the buildings. A dynamic simulation model was developed to provide half-hourly power demand under different scenarios, which was then compared with generation from potential solar PV. The results indicate that PV output could reduce electrical loads by around 30% while enhancing insulation could contribute to around 20% savings in energy demand. The paper includes economic analysis including annual savings in electricity bills, a discussion on the implication of the results on the proposed feed-in tariff, as well as generalised implications to the deployment of PV system at scale in domestic buildings in KSA.

Study the Effectiveness of Different Sun-Tracking Strategies for Muscat Area

Friday, 27th April - 15:38 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 81

Dr. Nabeel Al Rawahi [1], ***Dr. Nasser Al Azri*** [1]

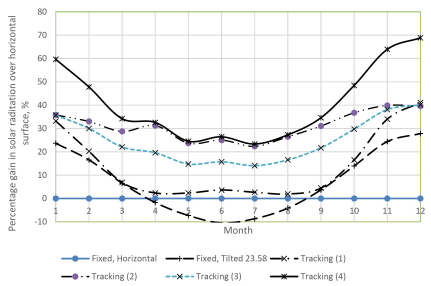
1. *Sultan Qaboos University*

Solar energy is considered, after hydro and wind, as the third renewable energy source in terms of globally installed capacity. Sun tracking systems are used to increase the produced power from solar panels by tracking the sun to be exposed to higher energy levels from the sun. Geometrically, the amount of solar radiation received by a flat solar panel is a function of the orientation of the panel with respect to the location of the sun. Therefore, it is important to know the effect of having sun-tracking system versus fixed panel in order to select the most appropriate system.

In this paper, the Effectiveness of Different Sun-Tracking Strategies is studies using measured average solar radiation in Seeb area which is in Muscat, Oman. The total solar radiation received by a solar panel tracking the sun is calculated considering direct beam, diffused , and reflected radiation components. The models used in estimating the various solar fluxes had been presented and validated by the authors in another published article.

The results show that sun tracking systems can provide, theoretically, annual gain of about 38% for two axes tracking systems and up to 30% for one axes systems, compared to fixed horizontal systems. The gain varies during the year and ranges from about 25% in the summer, to 70% and 40% during winter for two and one axes tracking systems, respectively. The results also showed that using a simple adjustable solar panel which is adjusted just twice a year (i.e. from tilting angle= 23.58^o to 0° in April and from 0° to 23.58^o in September) will perform closely like a solar tracker which depends on rotating the panel around the east-west axis. The adjustable system will provide about 5% annual gain and up to 27% gain in the winter.

It is obvious that the selection of certain solar tracking system should take into consideration similar analysis as performed in this work and the electricity load variation during the year. Similar study will be done for six more locations in Oman to get better understanding of the effect of the geographical location.



Effect of implementing different sun tracking strategies compared to fixed horizontal surface, where:
Tracking (1): Rotating the flat surface about a horizontal east-west axis with continuous adjustment (one axis).
Tracking (2): Rotating the flat surface a horizontal north-south axis with continuous adjustment (one axis).
Tracking (3): Rotating the flat surface about a vertical axis while maintaining a fixed tilting angle (one axis).
Tracking (4): Rotating about two axes (two axes tracking).

Figure for comparing sun tracking strategies.jpg

Renewable energy sustainability evaluation framework

Friday, 27th April - 15:55 - Photovoltaic and solar energy systems - Auditorium - Oral - Abstract ID: 268

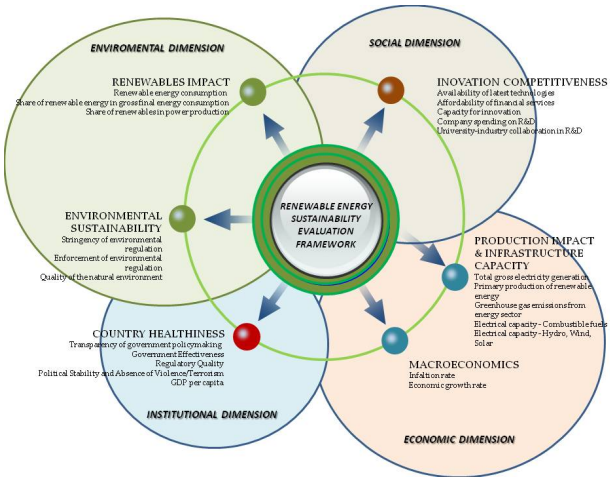
Mr. Stefan Cirstea [1], ***Mrs. Andreea Cirstea*** [2], ***Mr. Hagen Spielmann*** [3]

1. *Technical University Cluj-Napoca,* ***2.*** *Babes Bolyai University Cluj Napoca,* ***3.*** *Deutsches Zentrum für Luft und Raumfahrt (DLR)*

Renewable energy is a challenge for the future development of humanity. Considering the importance granted to this topic, lately, the paper aims to analyze, through a detailed statistical analysis, the intention of constructing a framework to assess the sustainability of renewable energy and to assess strengths and points that require attention and improvement in each country. Measuring the sustainability of this economic sector is of particular relevance in order to proactively and effectively determines investment decisions.

In order to achieve our research goals, we conducted a complex statistical analysis based on a set of relevant computation procedures such as Factor Analysis - Principal Component Analysis (FA-PCA). We tested our framework on three former communist countries with different development level, in order to observe if there are different manners of the renewable energy development. The proposed framework can reveal the development stages of renewable energy sustainability for the analyzed countries and can provide solutions to increase the sustainability of a country. In the same time, ALSCAL analysis was used to determine the distances between chosen states, measured Euclidian, based on the selected indicators. This type of analysis helps to produce a proximal distance map, the coordinates of the map axes being referred to in SPSS as "stimulus coordinates".

This paper focuses on the evaluation of country sustainability from economic, social, environmental and institutional perspectives and determines which the country trends are for the development of the renewable energy sector in order to help decision-makers for long-term investment. Otherwise, distances between selected countries, in terms of renewable energy sustainability was calculated.



Renewable energy sustainability evaluation framework.jpg

The effect of building energy management algorithms in battery aging

Friday, 27th April - 14:30 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 201

Dr. Lluc Canals [1], ***Mrs. Lucía Igualada*** [1], ***Dr. Cristina Corchero*** [1]

1. *Catalonia Institute for Energy Research (IREC)*

Smart buildings are a key element to walk towards smart cities and grids. Nonetheless, there are several degrees of intelligence. A first step is to incorporate commercial self-consumption solutions (kits) in buildings so they can manage the energy from local renewable power generators. Typically, these solutions have a management systems with some programmed scenarios where users configure their preferences. A second step would be to substitute these commercial management algorithms with an Energy Management System (EMS) to optimize the energy dynamic behavior and to reduce the electricity bill. Further, this EMS may contribute to stabilize and improve the quality and emissions of the electricity grid by offering energy flexibility to the electricity system in favor of decentralization. In the latter case, the energy that individual buildings may provide is too low to have a significant impact on the grid, this is when the figure of the Aggregator appears. The Aggregator gathers the energy flexibility of many buildings to respond to the electricity grid needs in a grouped way in constant communications with the EMS.

Buildings having an EMS count on several elements with different energy controllable capabilities; such as solar or wind generators, batteries, heating and cooling systems and electric vehicles among others. The optimization algorithms that control the use of these elements consider several technical restrictions or use conditions but none considers the aging of the battery. In fact, batteries age along time and use, losing capacity, power and efficiency as they grow older.

This study compares the battery aging between buildings that count with an EMS to optimize the electricity bill under three scenarios (Fig.1) in contrast to those that have the commercial management programs (Fig.2). Lithium ion battery lifespan is estimated by means of an electric equivalent battery circuit model that runs on Matlab and simulates its behavior through time.

Moreover, this study evaluates the distribution of the battery costs regarding its use, observing that batteries controlled by commercial self-consumption solutions have longer lifespan because they are underused, ending up in higher calendar ageing costs than the ones that are controlled by optimized EMS (Fig.3).

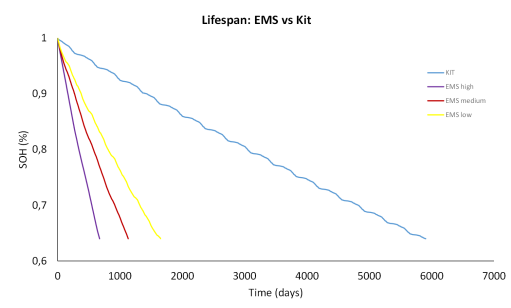


Fig2 lifespan of the battery for each scenario.png

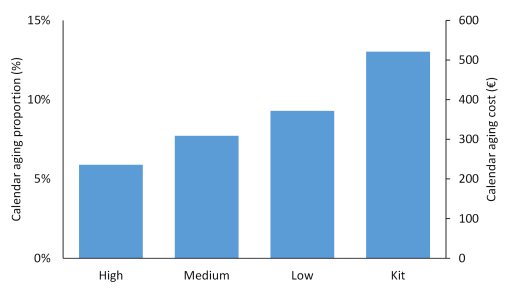


Fig3 proportion of battery degradation and cost caused by calendar aging.png

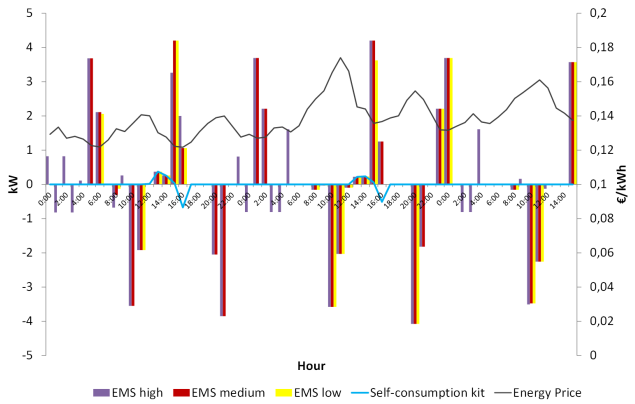


Fig1 use of the battery in each scenario against price.png

Optima real-time pricing scheme in smart grid considering time preference: A Stackelberg game model

Friday, 27th April - 14:47 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 367

Mr. RI PIAO [1], Prof. Deok-Joo Lee [1], Prof. Taegu Kim [2]

1. *Seoul National University,* ***2.*** *Hanbat National University*

Smart grid network enables more efficient energy consumption through communications between a provider and consumers. Once the energy provider declares a price policy, consumers are informed immediately through the communication channels such as the control units and update their energy consumption schedule to maximize own utility under the given pricing. In this research we propose a Stackelberg game model to analyze this two-stage decision making problem considering heterogeneous time preferences of consumers and restricted supply capacity. In the first stage, the energy supplier determines the optimal energy price for each time slot to maximize one's total profit. Following that, energy users determine the optimal energy consumption in each time slot.Equilibrium strategies in which the optimal consumption schedules of each consumer and the optimal real time pricing for the provider are analytically derived. To verify the effect of real-time pricing and time preference quantitatively, we performed the numerical example analysis using the equilibrium results of our model. Results suggest that the provider can induce consumers to use electricity in non-peak time hours by applying appropriate price policy thereby the peak to average ratio could be consequently decreased.

PORT FEASIBILITY STUDY TO SUPPORT OFFSHORE WIND FARMS AROUND EGYPT

Friday, 27th April - 15:04 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 355

Mr. Mostafa Mahdy [1]***, Mr. David Richards*** [1]***, Prof. AbuBakr Bahaj*** [1]

1. *Southampton University*

A pervious study to assist Egyptian's offshore wind potentials identified three different locations around the Red Sea, which can produce 33 GW of wind energy. The paper seeks to establish a feasibility assessment for the infrastructure and logistics port. Seven ports were evaluated using a group of criteria: quay length, water depth, loading capacity, cranes structure, distance to location, layout suitability and road network. The most suitable port final decision was rated using Multi-Criteria Decision Making (MCDM) methodology. Analytical Hierarchy Process (AHP) was used to calculate the relative importance of the different criteria considered. The primary results showed that "distance between port and wind farm location" factor is the most effective factor in the final decision.

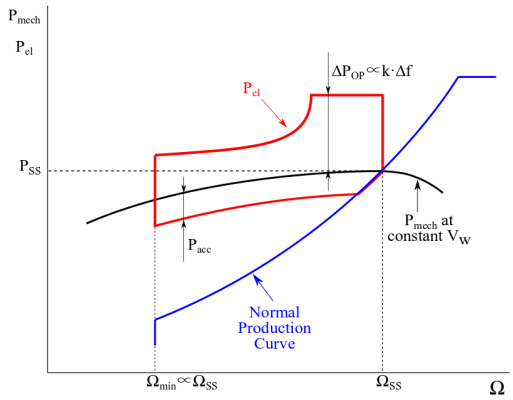
New fast power reserve emulation strategy for VSWT supporting frequency control

Friday, 27th April - 15:21 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 89

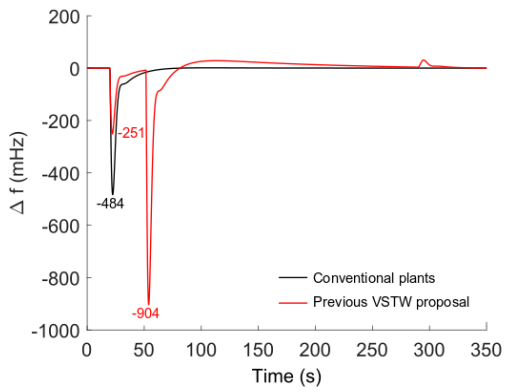
Ms. Ana Fernandez Guillamon [1], Dr. Antonio Vigueras-Rodriguez [1], Dr. Angel Molina-Garcia [1]

1. *Universidad Politécnica de Cartagena*

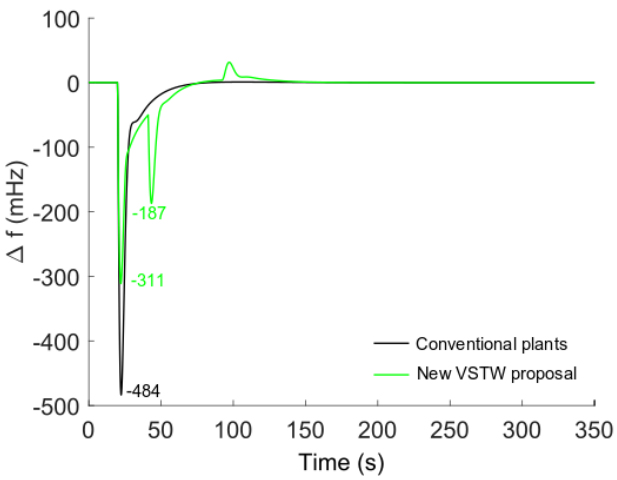
With the increasing number of variable speed wind turbines generators connected to the grid, new frequency control strategies need to be developed for them. This paper presents a new fast power reserve emulation controller for variable speed wind turbines under power imbalance conditions. It is based on the fast change of their rotor side converter active power set-point, having an over and an underproduction. Simulations are carried out on a typical power system consisting of thermal, hydropower and wind-power plants, considering the power imbalance as a step function. It is implemented in Matlab/Simulink and improves the frequency shift and settling-time found in a previous proposal. Extensive results are included in the paper.



Control.png



F1.png



F2.png

A simplified model for the dynamic analysis and power generation of a floating offshore wind turbine

Friday, 27th April - 15:38 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 184

Mr. Markus Lerch [1], ***Dr. Mikel De-Prada-Gil*** [1], ***Dr. Climent Molins*** [2]

1. *Catalonia Institute for Energy Research (IREC),* ***2.*** *Universitat Politècnica de Catalunya (UPC)*

Introduction

Floating offshore wind turbines are a promising solution that has been under development in recent years. With lower constraints to water depths and soil conditions, floating substructures enable to harness the abundant wind resources of deep waters and thus allow countries that lack shallow waters to develop offshore wind power. The objective of this paper is to develop a numerical model that allows capturing the main motions and response of a floating offshore wind turbine to wind and wave loads.

Methods

The floating wind turbine modeled in this study is the OC3-Hywind concept, which was chosen for the availability of data, the geometric simplicity and the relevance of the concept on the market. The model is developed using MATLAB and is tested for stability, natural frequencies and response to different external loads. The equation of motion is solved and a rigid body approach was used to model the system. The hydrodynamic forces are computed by using the Morison equation. A number of different load cases are used to test and validate the developed model. The specific behavior of the floating wind turbine is considered in the computation of the power output by reducing the inflow wind velocity by the platform pitch angle. The power performance of the floating offshore wind turbine is analyzed and compared to a bottom-fixed offshore wind turbine.

Results and Discussion

The objective was to develop a simplified model for a floating offshore wind turbine and to obtain the response of the dynamic behavior of this system. The model was built using MATLAB and the response of the system was evaluated and compared with results obtained by FAST in the OC3 project. It has been shown that the main motions and system's dynamics are captured by the simpler model with a comparable accuracy. Furthermore, the power production of the floating offshore wind turbine was computed and the performance discussed.

Electronic Differential And Neuro-Fuzzy Sliding Mode Control With Extended State Observer For An Electric Vehicle System

Friday, 27th April - 15:55 - Wind energy and smart grid - Room 207 - Oral - Abstract ID: 26

Mr. BOUGUENNA IBRAHIM FAROUK [1]

1. *RCAM Laboratory, Univeristy of Sidi Bel Abbes*

In this paper a neuro-fuzzy-sliding mode control (NFSMC) with extended state observer (ESO) technique is designed to ensure the traction of an electric vehicle with two separate permanent magnet synchronous motor (PMSM). Each PMSM systems (source-converter-motor) are coupled to an electronic differential (ED) in order to compensate the tendencies of direction of the vehicle and maintain a steady speed by adjusting the difference in speed of each motor-wheel according to the direction in the case of a turn. To ensure the control and performance of the vehicle a hybrid control scheme employs two types of controllers , neuro-fuzzy sliding mode control on the direct current loop and disturbance rejection control laws (ESO) on the Speed loop ,and quadrature current loop of the PMSM by taking into account the dynamic of the vehicle. Simulation under Matlab/Simulink to evaluate the efficiency and robustness of the proposed control method and ED on the closed loop system.

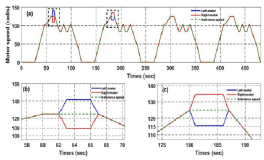


Fig1.jpg

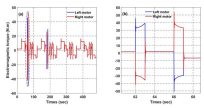


Fig2.jpg

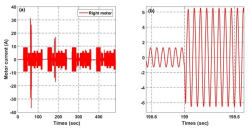


Fig3.jpg

Strategies towards high yield syngas production from solar CO2 recycling

Friday, 27th April - 16:40 - Hydrogen energy and fuel cell technology applications - Auditorium - Oral - Abstract ID: 298

Dr. Félix Urbain [1], ***Dr. Nina M. Carretero*** [1], ***Dr. Teresa Andreu*** [2], ***Prof. Joan Ramón Morante*** [2]

1. *IREC, Catalonia Institute for Energy Research,* ***2.*** *Catalonia Institute for Energy Research (IREC)*

The photo-electrochemical recycling of CO_2 emerged as alluring way to store intermittent renewable energy whilst converting it back into chemical fuels. In this contribution, we report on a novel prototype reactor device for high yield conversion of CO_2 to syngas (H_2 + CO), which by design, is integrated, scalable to large areas, and compatible with state-of-the-art photovoltaics and electrocatalysts. Within this contribution, mainly three aspects will be addressed: adaption and integration of silicon based solar cells as photoanodes, cathode material development, and prototype reactor assembly.

The application of silicon photovoltaic cells as photoanodes requires meeting challenges, such as increasing the photovoltage without impairing the photovoltaic efficiency; protection of the solar cell by robust coatings to increase the stability in aqueous electrolytes; and the decoration with catalysts ensuring an efficient oxygen evolution reaction (OER). Under photoelectrolysis conditions, the photovoltage can be adjusted up to 2.4 V by connecting up to four solar cells in series. We demonstrate that this high photovoltage of the photovoltaic structure enables the usage of earth-abundant catalyst materials for the OER, such as Ni.

The CO_2 reduction reaction is performed by large scale three-dimensional metallic foam cathodes, which are decorated with highly active nanosized catalysts for selective syngas production. We investigate the deposition of Zn and Ag catalysts on Cu- and Ni-foams. The performance of the as-produced (gas-diffusive) cathodes is evaluated in terms of product selectivity, Faradaic efficiency, overpotentials, and stability. Stable and tunable H_2:CO ratios between 5 and 1 along with high CO Faradaic efficiencies of up to 96% and CO current densities of 39.4 mA/cm^2 are measured (Fig.1).

In the complete integrated reactor assembly we combine the optimized silicon photoanode and the gas diffusive cathode (both with 10 cm^2 active surface area) and investigate the most efficient membrane configuration, in terms of low overall cell voltage. Additionally, we stepwise optimize the reactor, regarding clever packaging, efficient gas management, and electrolyte flow. Finally, we demonstrate a bias-free operation of the complete reactor device providing a photocurrent density of 5.0 mA/cm^2 measured under 100 mW/cm^2 illumination (Fig.2). This corresponds to a solar-to-syngas conversion efficiency of 4.3%.

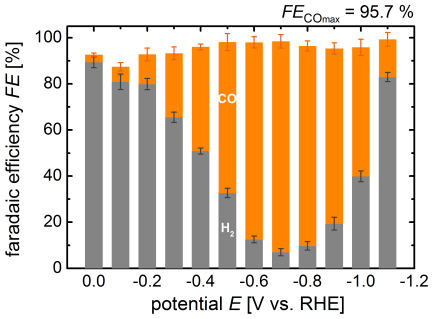


Fig.1 icren.png

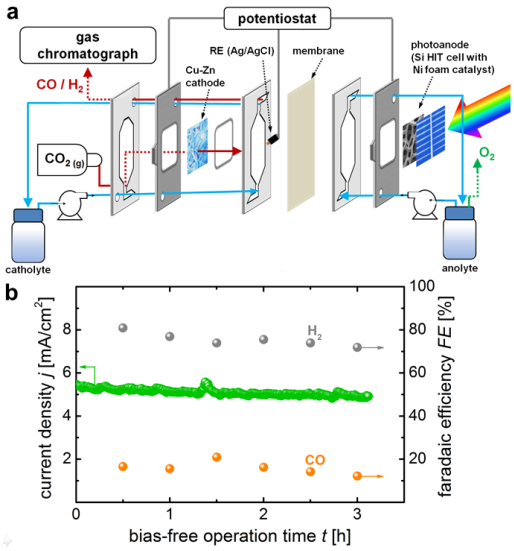


Fig.2 icren.png

O-methylene phosphonic κ-carrageenan as filler for chitosan-based polymer electrolyte

Friday, 27th April - 16:57 - Hydrogen energy and fuel cell technology applications - Auditorium - Oral - Abstract ID: 199

Dr. Kee Shyuan Loh [1]***, Ms. Joy Wei Yi Liew*** [1]***, Prof. Azizan Ahmad*** [1]***, Dr. Kean Long Lim*** [1]***, Prof. Wan Ramli Wan Daud*** [1]

1. *Universiti Kebangsaan Malaysia*

The potential for using O-methylene phosphonic κ-carrageenan (OMPk) as a filler in chitosan-based polymer electrolyte N-methylene phosphonic chitosan (NMPC) is investigated. OMPk, a new derivative of κ-carrageenan, is synthesized via phosphorylation and characterized using infrared spectroscopy (IR) and nuclear magnetic resonance (NMR). Both the IR and NMR results confirmed the phosphorylation of the parent carrageenan. The solid polymer electrolyte (SPE) based NMPC is prepared by solution casting with different weight percentages of OMPk ranging from 2wt% to 8wt%. The tensile strength of the polymer membrane increased from 18.02 MPa to 38.95 MPa as the amount of OMPk increased to 6wt%. However, the increase in the ionic conductivity did not match the increase in the tensile strength. The highest ionic conductivity is achieved with 4wt% OMPk, which resulted in 1.43 × 10-5 Scm-1. The κ-carrageenan based OMPk filler strengthened the SPE while maintaining an acceptable level of ionic conductivity.

Fabrication of one-dimensional PAN/g-C3N4 hollow nanofibers and improvement of photocatalytic properties

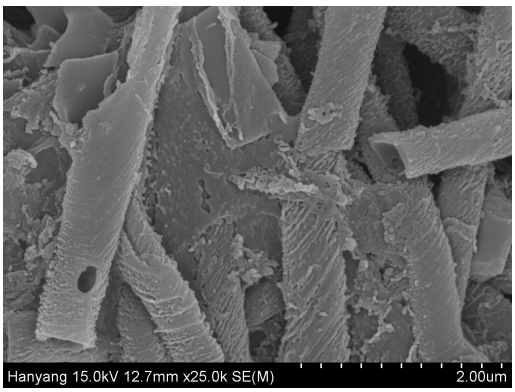
Friday, 27th April - 17:14 - Hydrogen energy and fuel cell technology applications - Auditorium - Oral - Abstract ID: 123

Mr. Joonyoung Jang [1]***, Ms. Suhee Kang*** [1]***, Prof. Caroline Sunyong Lee*** [1]

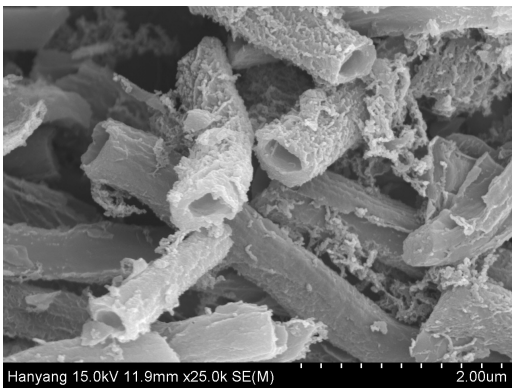
1. *Hanyang university*

To solve global warming and depletion of fossil fuels problem, efforts have been made worldwide to use solar energy. Based on this background, artificial photosynthesis mimics the natural photosynthesis mechanism. Recently, graphitic carbon nitride (g-C_3N_4), which is a non-metallic visible-light organic semiconductor, has been studied. g-C_3N_4 has good thermal and chemical stabilities and has a narrow bandgap energy of 2.6 eV. Urea, thiourea, melamine have been widely used as precursors for g-C_3N_4. These materials are inexpensive and can be readily used to synthesize g-C_3N_4. However, g-C_3N_4 has a high recombination rate, which lowers its photoelectrical activity. Copolymerization, doping, and the formation of composites and heterojunctions have been studied to overcome this issue. In our case, we coated one-dimensional (1D) g-C_3N_4 fibers on polyacrylonitrile (PAN) nanofibers using electrospinning method to fabricate a 1D heterostructure. This structure has numerous advantages including a high aspect and volume ratio, fast electron transfer rate, and provides effective separation of electron–hole pairs to reduce recombination.

PAN nanofibers with one-dimensional structure, were fabricated by electrospinning method so that the movement of electrons could be facilitated. In order to form hollow structure, it was carried in urea solution, and dried in the oven until the solution evaporated and obtained in powder form. After that, sintering was carried out in Ar atmosphere. Finally, one-dimensional hollow carbon nanofibers were obtained. After that, the precursor of g-C_3N_4under thesame process was used to uniformly coat the prepared hollow carbon nanofibers. For structural analysis, we observed hollow PAN/ g-C_3N_4nanofibers using SEM and TEM. FT-IR analysis and XPS analysis were performed for the physical property analysis, and specific peaks corresponding to g-C_3N_4were confirmed. In addition, the BET analysis was performed to confirm the specific surface area. As a result, it was confirmed that the one-dimensional hollow carbon nanofibers had an increased surface area about 3 times higher than that of the existing PAN nanofibers. In addition, PEC, EIS, and H_2production tests were performed to determine the electrochemical properties. Based on these analysis, it is expected to be applicable to solar cells, photocatalysts, hydrogen fuel cells, and lithium ion batteries.



Hcf tcn 15 q33.jpg



Hcf ar p3g u3g q65.jpg

Quantification on degradation mechanisms of polymer electrolyte membrane fuel cell catalyst layers during accelerated stress test

Friday, 27th April - 17:31 - Hydrogen energy and fuel cell technology applications - Auditorium - Oral - Abstract ID: 286

Dr. Raghunandan Sharma [1], ***Prof. Shuang Ma Andersen*** [1]

1. *Institute of Chemical Engineering, Biotechnology and Environmental Technology, Southern Denmark University, Odense*

Abstract:

Long term durability of the catalyst layers of a low working temperature fuel cell such as polymer electrolyte membrane fuel cell (PEMFC) is of significant scientific interest owing to their operation criteria and high initial cost. Identification of degradation mechanisms quantitatively during an accelerated stress test (AST) is essential to assess and improve the durability of such catalyst layers. In this study, we present a quantitative analysis of the degradation mechanisms such as (i) electronic connectivity loss due to carbon support corrosion, (ii) proton connectivity loss due to ionomer/catalyst interface loss, (iii) catalyst loss due to dissolution or detachment, and (iv) physical surface area loss due to particle growth responsible for the electrochemical surface area (ESA) loss in Pt-based catalyst layers for PEMFCs. Using a half membrane electrode assembly (half-MEA), where a gas diffusion electrode with genuine three-phase-boundaries is used as working electrode through solid electrolyte, we have observed the ESA loss due to ionomer/catalyst interface loss and identified catalyst heterogeneous degradation pattern during AST. Results suggest a significant ESA loss due to catalyst isolation from loss of electron and proton connectivities respectively by catalyst support corrosion and ionomer/catalyst interface loss (Fig. 1). Such knowledge and methodology can effectively contribute to catalyst material screening and electrode structure development to advance the PEMFC technology.

Figure caption:

Fig. 1: Contributions to ESA loss due to different mechanisms as obtained by AST through half-MEA setup

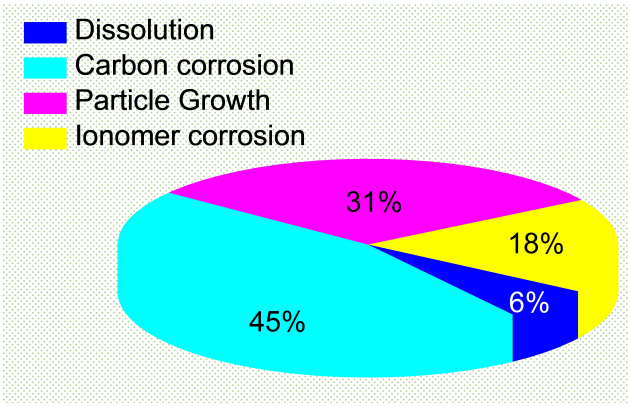


Fig. 1-degradation mech.jpg

The Impact of Regulatory Changes on The Feed-in Tariff at Grid-Connected Solar Photovoltaic Power Plant Growth in Indonesia

Friday, 27th April - 16:40 - Photovoltaic and solar energy systems - Room 207 - Oral - Abstract ID: 388

Dr. Brian Yuliarto [1]

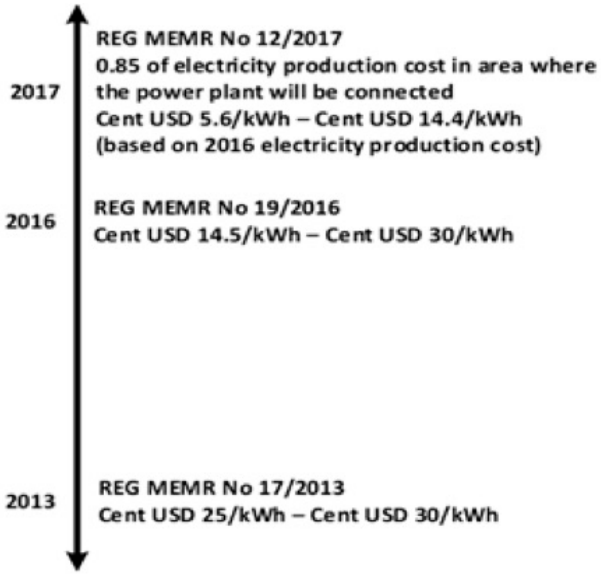
1. *Institut Teknologi Bandung*

Abstract—*Indonesia as an active country in the development of renewable energy in power generation has set the target of renewable energy contribution in National Energy Mix in 2025 and 2050. One of the most attractive Solar PV application in Indonesia is grid-connected solar photovoltaic power plant. It can be built on huge capacity, depend on stiffness of the system. The Indonesia Government has issued Presidential Decree No 22/2017 on the National General Energy Plan which states that the contribution of renewable energy in the national energy mix in 2025 should be at least 23% and in 2050 should be at least 31%. On such national regulation, contribution of solar energy in the national energy mix is targeted 4.6 % at 2025. The target is equivalent to total Solar Photovoltaic Power Plant capacity of 6.5 GW.*

However, during the last 5 years Indonesia has issued 3 technical regulations regarding feed in tariff for renewable energy power plant including Solar Photovoltaic (Solar PV). Those are: (1) Regulation of the MEMR on Utilization of Renewable Energy Resources, (2) Regulation of the MEMR on Purchase of Electricity from Solar Photovoltaics (Solar PV) by PLN, (3) Regulation of the MEMR on the Purchase of Electricity from Solar Photovoltaics (Solar PV) by PLN. Summary of content of the regulations are shown in Fig 1.

1. *Fig. 1.Summary of regulatory changes on the feed-in tariff at grid-connected solar photovoltaic power plant in Indonesia*

The result of the model shows that fit policy changes impact on Grid-Connected Solar PV capacity growth in Indonesia. The two previous Regulation of the Minister of Energy and Mineral Resources No. 17/2013 and 19/2016 can boost installed PV because of the attractive electricity-selling price of Grid-connected Solar PV. Decrease of electricity selling price according to Regulation of the Minister of Energy and Mineral Resources No. 12/2017 is expected to have an impact on the declining growth in Grid-connected Solar PV capacity in Indonesia. Thus, it is recommended that regulatory improvements could encourage the growth of Grid-connected Solar PV capacity while simultaneously lowering the electricity production cost in each region.



2018 icren figabstract.jpg

Optimal management of microgrid with PV penetration and Storage: La Graciosa case study

Friday, 27th April - 16:57 - Photovoltaic and solar energy systems - Room 207 - Oral - Abstract ID: 222

Mr. Guillermo Dominguez [1], ***Mr. Pol Paradell*** [1], ***Dr. Jose Luís Dominguez*** [1], ***Mr. Jacob Rodriguez*** [2], ***Mr. Jorge Sanchez*** [2]

1. *Catalonia Institute for Energy Research (IREC),* ***2.*** *Endesa*

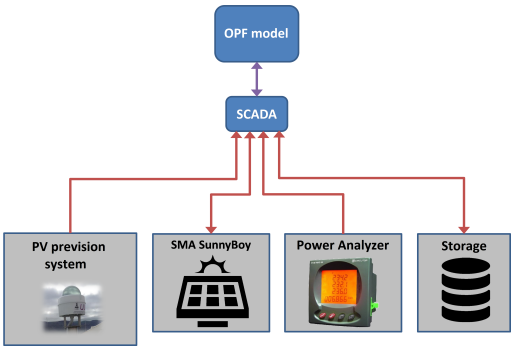
Future power systems with high penetration of renewable generation and ICT, will allow increasing the controllability and observability of the grid. However, new challenges for low voltage distribution networks has arisen where the increasing distributed generation is mainly PV installed on the roofs of buildings. This type of generation is variable and generates disturbances in the network. Islands are ideal to experience and install new technologies since are weak grids and the penetration of PV will lead to bidirectional power flows at distribution level, thus a smart control will be required.

This article aims to present and innovative tool for the DSOs to monitor and manage grid operation. In near future, both distributed renewable generation and client's flexibility will increase. New monitoring and control tools for DSOs are essential. Furthermore, the grid operation optimization is needed to accommodate the expected DER installations and the active participation of consumers' flexibility services in markets ensuring system efficiency. This tool is tested on "La Graciosa" grid, one of the Canary Islands, to show its benefit. The grid includes HESS, PV generators and controllable/uncontrollable loads as well as some power analysers installed along the lines to monitor the grid.

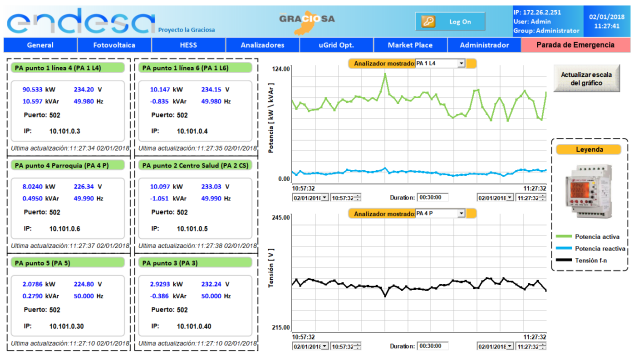
This research tool comprises both an OPF and a SCADA. The former determines the best operating level for each generator or storage in the microgrid to meet demand and reduce losses maximizing PV penetration. By using the data obtained including PV prediction and HESS status, the OPF can set the current and predict future states by means historical values. A scheme of the architecture considered is shown in file "Scheme_of_the_architecture_considered.png".

A SCADA application is also designed to manage in real time the microgrid. The SCADA centralizes all the data and stores it to feed the OPF model with real time values, collects the calculated setpoint and stablish the communications between all the devices installed. Some screens of the SCADA can be seen in files "Grid_sketch_screen_on_the_SCADA.png" and "Power_analysers_data_on_the_SCADA.png" where the real implementation is shown.

Grid sketch screen on the scada.png



Scheme of the architecture considered.png



Power analysers data on the scada.png

Hybrid renewable energy system: tidal current turbine & solar power electrification system on One Fathom Bank

Friday, 27th April - 17:14 - Photovoltaic and solar energy systems - Room 207 - Oral - Abstract ID: 294

Ms. Cassandra Gail Abdullah [1], ***Dr. Shamsul Sarip*** [1], ***Mr. Noraimi Shafie*** [1], ***Ms. Nur Amani Natasha Mahadzir*** [1]

1. *UNIVERSITI TEKNOLOGI MALAYSIA*

Renewable energy resources are becoming inexorably in the field of generating electrical power due to the fast development of technology, given to its advantages over non-renewable energy resources. Aside from being eco-friendly, renewable energies are non-depletable unlike conventional energy resources, not only becoming exhaustible and degrading each day but also pollutes the environment. Though the source is available in enormous amount, energy produced from single renewable energy resources such as tidal current may fluctuate with the time and the hour of the day or month, depending on the tides. Thus, by having a hybrid power system consisting two or more renewable energy resources coming into play at the same time would be more reliable to support the targeted area. However, the availability of renewable energies depends on the climate change, therefore having a backup power is often essential. In this case, the main purpose of this research is to develop an off-grid hybrid tidal current and solar power system along with backup sources to support One Fathom Bank Lighthouse with the intention to eliminate the usage of diesel generators as a main current source to the building. Having the ability to evaluate economic and technical feasibility of power system, HOMER software is used to run simulation and analyze the most optimum configuration of hybrid power system. The results are based on the best components and sizing with an appropriate operating strategy to provide efficient, reliable and cost-effective system. Thus, the research obtained is able to be used as a feasibility study for any future references.

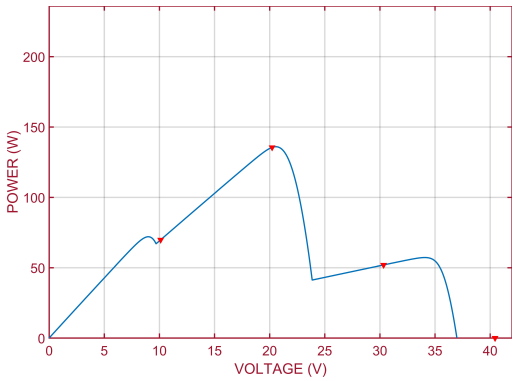
Performance Evaluation of Solar MPPT Technique using Fast and Improved PSO (FIPSO) Under Partial Shading Conditions.

Friday, 27th April - 17:31 - Photovoltaic and solar energy systems - Room 207 - Oral - Abstract ID: 23

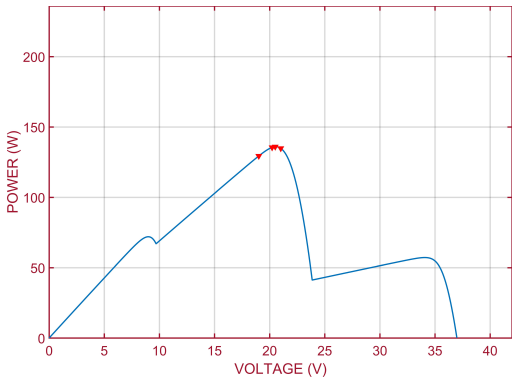
Mr. Tabish Imtiaz [1], ***Prof. Badrul Hasan Khan*** [1]

1. *Aligarh Muslim University*

Partial shading is a menace to the PV power generation systems which is practically unavoidable. Non-uniform shading can be due to clouds, tree branches, buildings or other nearby items. The non linear output characteristics of a PV source varies with temperature and solar insolation. Whenever partial shading condition occurs, the conventional hill climbing methods of MPPT prove to be inefficient. During partial shading the power-voltage (P-V) curve exhibits multiple peaks. Conventional MPPT methods get stuck on one of the local maxima and fail to attain the global maximum power point (GMPP). Particle swarm optimisation (PSO) has proved to be a very accurate and powerful technique to find GMPP. In this paper we improve the conventional PSO by reducing swarm size, as well as, the number of iterations to achieve MPP at a fast pace with remarkable accuracy, thus making our system more efficient with less computation requirements. Simulation and performance evaluation of the proposed technique under different partial shading conditions prove its advantages, such as flexibility, reliability, system-independence and high accuracy in tracking the GMPP under non uniform insolations.
The first figure (Particle Initialisation (4 particles)) shows the initialisation of the the swarm particles, which are very close to the local maxima occurring in the P-V characteristics. The second figure (Convergence in 5 Iterations) shows that in just 5 iterations, using the FIPSO algorithm, the particles have managed to converge at the global maximum.



Particle initialisation 4 particles .jpg



Convergence in 5 iterations.jpg

The analysis and comparision of the efficiencies of different household firewood stoves; a case study Ndejje, central Uganda

Friday, 27th April - 19:00 - Online Presentations - Online - Video - Abstract ID: 311

Ms. Amanda Auma [1], Mr. Henry Wasajja [1], Prof. Albert Rugumayo [1]

1. *Ndejje University*

This study was carried out in the 'cattle corridor' is a belt which traverses the south west and northeast of Uganda. The cattle corridor has expereinced significant environmental degradation as a result of overstocking and overgrazing of cattle, coupled with poor agriculutral practices.

The main objective of the the study was to compare the efficiencies of four different types of household firewood stoves. These are; i) the gasifier stove, ii) the rocket stove, iii) the biolite stove and iv) three-stone cooking stove and therefore recommend the preferred stove for similar rural areas.

The efficiency of the stoves depended on several factors; which include: i) skill / training of the cook tending the stove, ii) fuel (diameter, moisture content, density, wood species, etc.) iii) stove design, iv) fit of the pot to the stove and v) type of food and type of cooking performed. All the above factors are important and they were therefore considered and kept constant determination of the efficiencies of the different stoves selected.

In addition to the above, the following important criteria were considered in determination of stove efficiency:

i) Social: This includes the cooking task (boiling, frying, baking, grilling, steaming etc.), utensils used, size of cooking operation, affordability, culinary practices.

ii) Engineering: power output, pot and pan sizes and shape, materials available, knowhow and skills needed for operating stove.

iii) Developmental & ecological: fuel access, smoke problems (indoor/outdoor cooking), potential for job creation, etc.

In this study, we used the *Water Boiling Test*and the *Controlled Cooking Test* for verifying the stove efficiency.

The results showed that the gasifier and biolite stove and rocket stoves were the most efficient stoves in that order and they also confirmed that the three-stone fire has very low efficiency in cooking.

It was therefore recommended that the local Ugandan people, especially the population in the project study area, should use improved cook stoves for improved and sustainable health, economic and social development as well as environmental protection.

Design of Vehicle Controller of Pure Electric Bus Based on CAN Bus

Friday, 27th April - 19:01 - Online Presentations - Online - Video - Abstract ID: 356

Prof. Yi Han [1], ***Mr. Shiwei Tu*** [1], ***Mr. Jianjun Li*** [1]

1. *School of Automobile, Chang'an University*

In this paper, a pure electric bus is used to analyze the requirements of vehicle network communication. The J1979 protocol is chosen and the serial communication protocol CAN 2.0B is adopted as the network core protocol. The maximum communication speed is up to 250Kbps. According to the function and requirements of the vehicle controller, this paper proposes a new vehicle controller design. Freescale 32-bit MPC5644A is selected as the master chip, and the peripheral circuits such as microprocessor module, power supply module, analog and digital interface module, power driver module and communication module are designed according to the modularization method. Moreover, this paper conducts the anti-interference design . At the same time, the control strategy based on logic threshold is adopted and the program is programmed to control the functions of vehicle power, energy optimization, braking feedback and network management. By collecting drivers' driving signals and using CAN bus to manage, schedule, analyze and calculate the network information, the bench test is carried out to verify the functions of the vehicle controller. Experiment results show that the vehicle controller designed in this paper has stable performance and reliable work and can meet the initial design requirements.

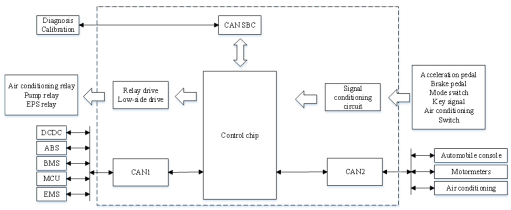


Figure 1 vehicle controller structure control block diagram.png

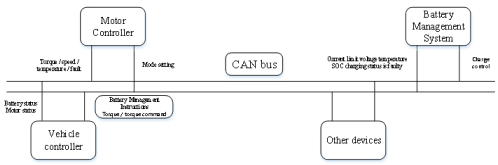


Figure 2 can bus communication.png

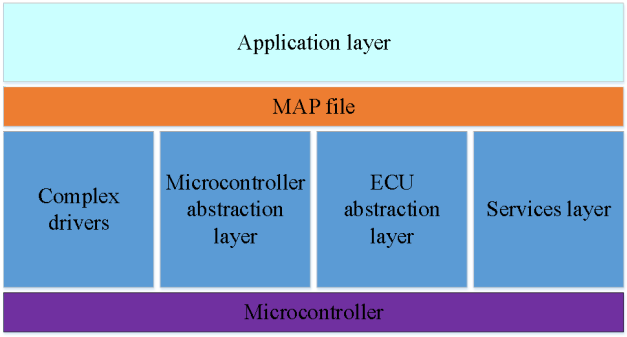


Figure 3 vehicle controller software control block diagram.png

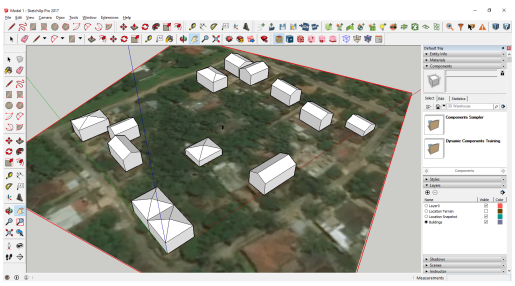
The potential of building integrated photovoltaics in Jaffna, Sri Lanka

Friday, 27th April - 19:02 - Online Presentations - Online - Video - Abstract ID: 363

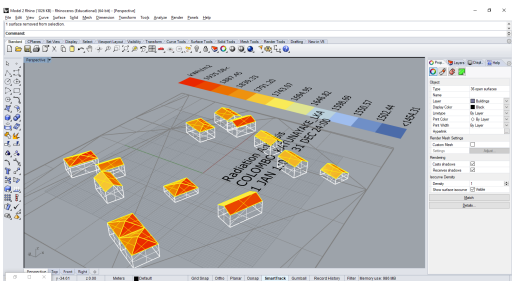
Ms. Thushini Mendis [1]

1. *General Sir John Kotelawala Defence University/ Huazhong University of Science and Technology*

Solar energy is a renewable energy resource that is available in abundance in the island of Sri Lanka. The use of non-renewable energy sources has greatly augmented in recent years, rapidly approaching the point of depletion. This remarkable increase in energy consumption and carbon dioxide emissions has progressed to become an extremely worrisome contributing factor in the construction industry. The primary aim of this research is to attempt to determine the potential of a household in the district of Jaffna to produce renewable energy via the use of photovoltaic technology in hopes of combating climate change. This research utilises quantitative methods in order to approach the research question, which is whether the implementation of BIPV in the domestic context in Jaffna would be a sound investment, and render the need for non-renewable sources of energy unnecessary. Rhinoceros is used to model the domestic context, and the Ladybug and Honeybee tools, which make use of the RADIANCE simulation engine, are utilised via the Grasshopper plug-in in order to simulate and analyse solar irradiation incident upon the building roofs. A simple CO_2 emissions savings analysis and cost analysis are also carried out in order to determine the economic feasibility of the project. The results show that rooftops in Jaffna receive plentiful solar irradiation, well exceeding threshold values, and the average solar irradiation incident upon a household rooftop is 373,349 kWh. This allows a total PV generation of at least 5 times more than the power demand per household (considering a panel efficiency of 15%). With the use of existing statistical data, the electricity consumption per household is obtained, and thus the annual electricity cost savings that could be achieved by the implementation of BIPV is calculated to be 396,168 LKR. Considering an initial investment of roughly 1.8 million LKR, which is obtained from manufacturer's catalogues, the implementation of BIPV in domestic buildings in Jaffna would be able to break even by Year 5. These values subsequently help to answer the research question that the utilisation of BIPV could completely eradicate the need for fossil fuel energy in the domestic sector of Jaffna.



Sketchup model.png



Visualised results.png

Annual Electricity Consumption Per Household (kWh)	9600
Average Roof Area Per Household (m^2)	204.3
Average Solar Irradiation Incident Per Household Rooftop (kWh)	373348.962
Total PV Electricity Generation Per Household (kWh)	56002.3442
Total Emissions Savings Per Household (kg)	6816
Cost of Investment (LKR)	1,802,717
Annual Electricity Cost Savings (LKR)	396168
Breakeven Point	**Year 5**

Table of results.png

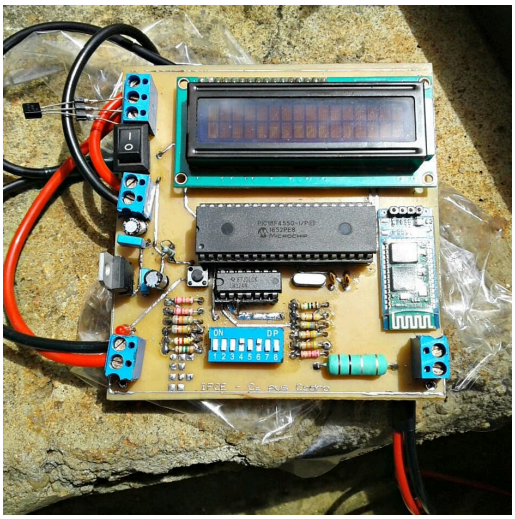
A low-cost micro-controlled acquisition and remote monitoring (MARM) system for photovoltaic data analysis

Friday, 27th April - 19:03 - Online Presentations - Online - Video - Abstract ID: 423

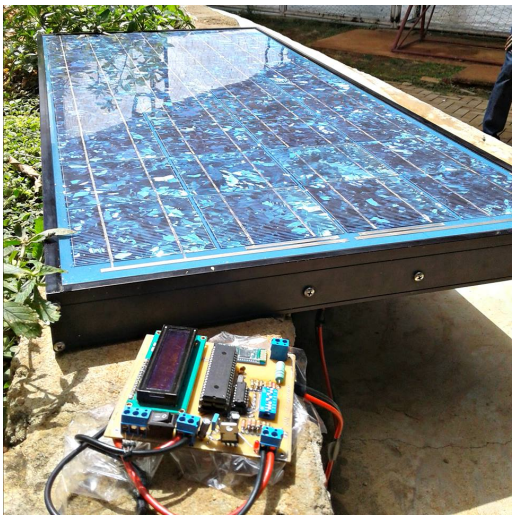
Prof. Ronnyel Silva [1], ***Prof. Humberto Beltrao*** [1], ***Mr. Jefté Brito*** [1], ***Mr. Jefferson Fernandes*** [1]

1. *Federal Institute of Education, Science and Technology of Ceara*

The best production of the solar energy is obtained under a continuous photovoltaic (PV) panels monitoring. Such task may be performed in different ways, including watermarking techniques to ensure a real monitoring and real-time physical quantities data analysis using embedding systems. In order to give the PV panel's supervisor a way to analyze its power capacity, this work proposes a micro-controlled acquisition and remote monitoring (MARM) system. For the data acquisition unit (DAU), a 18F4550 PIC microcontroller and HC-06 Bluetooth module were used. Aiming to perform a remote supervision, an Android app representing the data monitoring unit (DMU) was implemented. Both parts of the system establish a Bluetooth communication so that when some want to check panel's health, which includes voltage, current or even temperature in a given period of time, he picks the desired magnitude using the app's interface. Once the DAU is attached to the PV the data start to be collected. In a way to monitor the temperature of the panel, an LM35 sensor was used. For current, a shunt resistor and an operational amplifier were considered. It has allowed a 0,002A measurement error. For voltage, the error was about 0,025V using a voltage divider. The MARM operates according to three different voltage-current configurations: 25V - 2A, 50V - 4A and 100V - 6A. These values were chosen in order the system to serve a higher number of different PV panels configurations. The first configuration (25V-2A) is the default one. Tests were performed using a 110cm x 53cm PV module which reaches 56.95W of maximum power. For all the data types considered, the system has operated as expected, and their analysis could be performed properly. Although the tests have been performed using a single PV module, a series/parallel configuration may also be used, due to the different voltage-current configurations considered. At the time the system was developed it cost $32 (USD) approximately.



Dau.jpg



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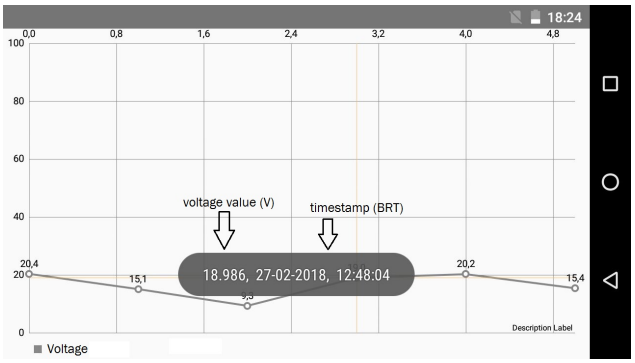

Dmugraph.jpg

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