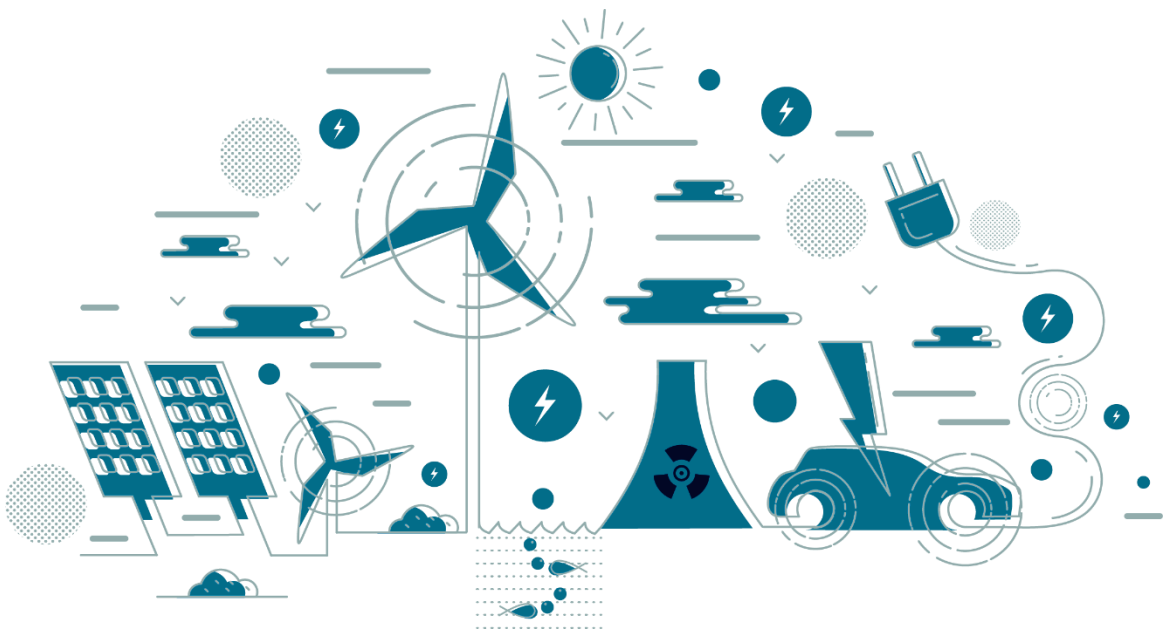




7th INTERNATIONAL CONFERENCE ON ADVANCES IN ENERGY RESEARCH

10-12 December 2019

Programme Booklet



Department of Energy Science and Engineering
Indian Institute of Technology Bombay
Powai, Mumbai 400076, INDIA

**7th International Conference on Advances in Energy Research
(ICAER 2019)**

10-12 December 2019

Programme Booklet



**Department of Energy Science and Engineering
Indian Institute of Technology Bombay
Powai, Mumbai 400076, Maharashtra, India**

Foreward

The Department of Energy Science and Engineering (DESE) at IIT Bombay is a leading interdisciplinary energy education and research centre. DESE has developed several novel education programs focussing on the application of science and engineering to problems in energy. Keeping the vision of the department “To develop sustainable energy systems and solution for the future” in mind, there is a strong need of providing a common platform to the researchers in the field of energy and allied domains. DESE has been organising the biennial conference International Conference on Advances in Energy Research since 2007 which serves as an excellent forum to present new findings, exchange novel ideas, discuss new developments, and reflect on the challenges that lie ahead.

This book is a compendium of all the abstracts of the submissions accepted at the 7th International Conference on Advances in Energy Research (ICAER 2019), organised from 10-12 December 2019. After a rigorous peer review process, about 230 papers have been accepted for oral and poster presentation at the conference. The conference proceedings will be published as a book volume in Springer Proceedings in Energy. The authors of the selected best papers from ICAER 2019 shall be invited to submit full-length manuscripts for publication consideration in Particulate Science and Technology or Solar Energy.

Various aspects of energy research including, but not limited to, conventional energy, renewable energy, energy storage, energy efficiency and modelling, energy policy and economics, and energy education are covered in this conference. This conference throws light on various recent accomplishments by researchers worldwide in the areas of solar thermal, thermal storage, solar PV with new materials, novel batteries, biofuels-based transportation and rural energy needs, to name a few. The conference also includes a special session on ‘Industry innovations in energy’ where leading experts from industry are invited to present innovative case studies from their respective industries.

As a part of the conference, two international workshops are also organized. These are the International Workshop of Hydrogen Storage and the Springer Nature author workshop on how to write and submit manuscript for journal publications.

We would like to take this opportunity to thank all the invited speakers, delegates, sponsors, the members of the organising and advisory committee and most importantly the students and staff of DESE for their dedicated efforts in organising this conference.

Prof. Manaswita Bose
Organising Secretary, ICAER 2019

Prof. Anish Modi
Organising Secretary, ICAER 2019

Contents

1. Scientific Advisory Committee.....	5
2. Local Organizing Committee	7
3. Conference Schedule	9
4. Invited Talks	23
5. Abstracts	39
6. Industry Innovations in Energy.....	185

Scientific Advisory Committee

Ahmad Agus Setiawan, Universitas Gadjah Mada, Indonesia
Ajit Kolar, IIT Madras, India
AKM Sadrul Islam, IUT Dhaka, Bangladesh
Ashvini Kumar, The Energy and Resources Institute (TERI), India
Birgitte Bak-Jensen, Aalborg University, Denmark
D. Yogi Goswami, University of South Florida, USA
Evelyn N. Wang, Massachusetts Institute of Technology, USA
Jacques Huot, Univ. du Québec à Trois-Rivières, Canada
Janaka Ekanayake, University of Peradeniya, Sri Lanka
Nishanth Chemmangattuvalappil, University of Nottingham, Malaysia
Pradip Dutta, IISc Bangalore, India
Prashant V. Kamat, University of Notre Dame, USA
Rakesh Agrawal, Purdue University, USA
Ralph Gottschalg, Fraunhofer Center for Silicon Photovoltaics CSP, Germany
Ramesh Kumar Maskey, Kathmandu University, Nepal
Ranga Pitchumani, Virginia Tech, USA
Raymond R. Tan, De La Salle University, Philippines
Sankar Bhattacharya, Monash University, Australia
Sreedevi Upadhyayula, IIT Delhi, India
Svati Bhogle, Sustaintech and Technology Informatics Design Endeavour (TIDE), India
Tara Chandra Kandpal, IIT Delhi, India
Tilak Siyambalapitiya, Resource Management Associates (Pvt) Ltd, Sri Lanka
Tshewang Lhendup, College of Science and Technology (CST), Bhutan
Vinu Ravikrishnan, IIT Madras, India
Virendra Puri, PennState, USA
Yuan Xu, Chinese University of Hong Kong, Hong Kong

Local Organizing Committee

Anish Modi
Asish Kumar Sarangi
Balasubramaniam Kavaipatti
Chetan Singh Solanki
Dayadeep Monder
Karthik Sasihithlu
Lalit Kumar
Manaswita Bose
Manoj Neergat
Prakash Chandra Ghosh
Pratibha Sharma
Rajesh Gupta
Rangan Banerjee
Sagar Mitra
Sandeep Kumar
Sankara Sarma V Tatiparti
Santanu Bandyopadhyay
Shaibal K Sarkar
Shireesh B Kedare
Srinivas Seethamraju
Suneet Singh
Suryanarayana Doolla
VSS Pavan Kumar Hari
Venkatasailanathan Ramadesigan
Zakir Hussain Rather

Conference Schedule

Day 1, 10 Dec 2019

Time	Paper Id	Title
8:00 AM - 9:00 AM	Registration and Breakfast, Cafeteria, Ground floor	
9:15 AM - 9:55 AM	Inauguration, Main Auditorium, Ground floor	
10:00 AM - 11:00 AM	Invited talk	Prof. Diana Urge-Vorsatz, Main Auditorium, Ground floor
11:00 AM - 11:25 AM	Tea Break, Foyer, First floor & Cafeteria, Ground floor	
11:30 AM - 1:00 PM	Session 1.1a: Solar PV, Room 11, First floor	
11:30 AM - 11:45 AM	055	Power Management of non-conventional Energy resources based DC Microgrid supported by hybrid energy storage
11:45 AM - 12:00 PM	068	Performance Evaluation of Wind - Solar Hybrid Systems in Indian Context
12:00 PM - 12:15 PM	087	Investigation on Different Types of Electric Storage Batteries used in offgrid Solar Power Plants and Procedures for their Performance Improvement
12:15 PM - 12:30 PM	176	Correlating partial shading and operating conditions to the performance of PV panels
12:30 PM - 12:45 PM	193	Assessment of Different Multiclass SVM Strategies for Fault Classification in a PV System
12:45 PM - 1:00 PM	214	Automated cleaning of PV panels using the comparative algorithm and Arduino
11:30 AM - 1:00 PM	Session 1.1b: Solar Thermal, Room 12, First floor	
11:30 AM - 11:45 AM	018	Solar Energy for Meeting Service Hot Water Demand in Hotels: Potential and Economic Feasibility in India
11:45 AM - 12:00 PM	019	Techno-economic feasibility of condenser cooling options for solar thermal power plants in India
12:00 PM - 12:15 PM	020	Optical Modelling of Parabolic Trough Solar Collector
12:15 PM - 12:30 PM	037	Thermo-Hydrodynamic Modeling of Direct Steam Generation in Parabolic Trough Solar Collector
12:30 PM - 12:45 PM	058	Sizing of a solar powered adsorption cooling system for room cooling needs
12:45 PM - 1:00 PM	078	Mathematical Analysis of Convection Heat Loss from Solar Cavity Receiver Dish Concentrator
11:30 AM - 1:00 PM	Session 1.1c: Biomass and Bio fuels, Room 13, First floor	
11:30 AM - 11:45 AM	030	Development of an Improved Cookstove: An Experimental Study
11:45 AM - 12:00 PM	034	Double Dielectric Barrier Discharge-Assisted Conversion of Biogas to Synthesis Gas
12:00 PM - 12:15 PM	043	Hydrodeoxygenation of Bio-oil from Fast Hydrolysis of Pinewood over Various Catalysts
12:15 PM - 12:30 PM	110	Rice Paddy as a Source of Sustainable Energy in India

12:30 PM - 12:45 PM	198	Extinction of non-premixed 'volatiles' flame: Experiments on single biomass particles and connection to counter-current flame propagation in packed beds
12:45 PM - 1:00 PM	209	Effect of Injection Pressure on the Performance Characteristics of Double Cylinder 4-Stroke CI Engine using Neem Biodiesel.
11:30 AM - 1:00 PM	Session 1.1d: Energy policy, economics, management, Room 14, First floor	
11:30 AM - 11:45 AM	023	The Human Dimension of Household Electricity Consumption: A Structural Equation Modelling Approach
11:45 AM - 12:00 PM	051	Environmental disclosure regulation and low carbon growth: Evidence from firm level data
12:00 PM - 12:15 PM	090	Study of effects of water inlet temperature and flow rate on the performance of Rotating Packed Bed
12:15 PM - 12:30 PM	111	Cost and Emission Trade-offs in Electricity Supply for the state of Maharashtra
12:30 PM - 12:45 PM	273	Effective use of Existing Efficient Variable Frequency Drives (VFD) technology for HVAC systems – Consultative Research Case Studies
12:45 PM - 1:00 PM	275	Thermodynamic Analysis of a Combined Power and Cooling System Integrated with CO ₂ Capture Unit of a 500MWe SupC Coal-fired Power Plant
1:00 PM - 1:55 PM	Lunch, Second floor & Cafeteria, Ground floor	
2:00 PM - 3:30 PM	Session 1.2a: Solar PV, Room 11, First floor	
2:00 PM - 2:15 PM	247	Assessment of Floating Solar Photovoltaic (FSPV) Potential in India
2:15 PM - 2:30 PM	249	Policy intervention for promoting effective adaptation of rooftop solar PV systems
2:30 PM - 2:45 PM	254	A Simplified Non-Iterative Method for Extraction of Parameters of Photovoltaic Cell/Module
2:45 PM - 3:00 PM	262	Design and Fabrication of Grating based Filters for Micro-thermophotovoltaic Systems
3:00 PM - 3:15 PM	270	Analysis of Nature Inspired Spirals for Design of Solar Tree
3:15 PM - 3:30 PM	277	DFT studies on electronic and optical properties of inorganic CsPbI ₃ perovskite absorber for solar cell application
2:00 PM - 3:30 PM	Session 1.2 b: Solar Thermal, Room 12, First floor	
2:00 PM - 2:30 PM	Invited Talk	Prof. Pradeep Dutta
2:30 PM - 2:45 PM	083	Effect of Top Loss and Imperfect Regeneration on Power Output and Thermal Efficiency of a Solar Low Delta-T Stirling Engine
2:45 PM - 3:00 PM	118	Desalination using Waste Heat Recovery with Active Solar Still
3:00 PM - 3:15 PM	137	Experimental Investigations of Drying Characteristics of Thompson Seedless Grapes using Solar Energy
3:15 PM - 3:30 PM	142	Performance assessment and parametric study of multiple effect evaporator

2:00 PM - 3:30 PM	Session 1.2 c: Nuclear Energy, Room 13, First floor	
2:00 PM - 2:30 PM	Invited Talk	Prof. Carlos Alberto Dorao
2:30 PM - 2:45 PM	017	Does the criteria of instability thresholds during Density Wave Oscillations need to be redefined?
2:45 PM - 3:00 PM	100	Computation of Higher Eigenmodes using Subspace iteration scheme and its application to Flux Mapping System of AHWR
3:00 PM - 3:15 PM	280	Safety Analysis of Loss of NPP off-site power with failure of Reactor SCRAM (ATWS) for VVER-1000
3:15 PM - 3:30 PM	336	Comparison of Physics Characteristics of Pressurized Water Reactor Type Advanced Light Water Reactors
2:00 PM - 3:30 PM	Session 1.2d: Biomass and biofuels, Room 14, First floor	
2:00 PM - 2:15 PM	231	Experimental Investigation of a biogas fueled diesel engine at different biogas flow rates
2:15 PM - 2:30 PM	245	A comparative experimental investigation of improved biomass cookstoves for higher efficiency with lower emissions
2:30 PM - 2:45 PM	259	Carbon deposition on the anode of a solid oxide fuel cell fueled by syngas – A thermodynamic analysis
2:45 PM - 3:00 PM	279	Bio-ethanol production from carbohydrate-rich microalgal biomass: <i>Scenedesmus obliquus</i>
3:00 PM - 3:15 PM	298	Performance and Emission Characteristics of CI Engine Fueled With Plastic Oil blended with Jatropha Oil And Diesel
3:15 PM - 3:30 PM	306	Thermochemical conversion of tomato plant waste for liquid fuel production
3:30 PM - 4:00 PM	Tea Break, Foyer, First floor & Cafeteria, Ground floor	
4:00 PM - 5:30 PM	Session 1.3a: Electrochemical storage, Room 11, First floor	
4:00 PM - 4:15 PM	072	Structural, Electrical and Cell Performance Study on Lithium Germanium Phosphate Glass-Ceramics based Solid State Li-Electrolyte
4:15 PM - 4:30 PM	125	Development of a dynamic battery model and estimation of equivalent electrical circuit parameters
4:30 PM - 4:45 PM	206	Studies on the Use of Thorium in PWR
4:45 PM - 5:00 PM	236	Characteristics of an Indigenously Developed 1 kW Vanadium Redox Flow Battery Stack
5:00 PM - 5:15 PM	288	Electrodeposition of Cu ₂ O: Determination of limiting potential towards solar water splitting
5:15 PM - 5:30 PM	356	Highly Stable Pt/CVD-Graphene Coated Superstrate Cu ₂ O Photocathode for Water Reduction
4:00 PM - 5:30 PM	Session 1.3 b: Energy policy, economics, management, Room 12, First Floor	
4:00 PM - 4:15 PM	120	Incorporating battery degradation in stand-alone PV microgrid with hybrid energy storage

4:15 PM - 4:30 PM	130	Investigation of Energy Performance of a High Rise Residential Building in Kolkata through Performance Levels of Energy Conservation Building Code, 2017
4:30 PM - 4:45 PM	145	Dynamic modelling of natural gas market based on impact assessment: An Indian case study
4:45 PM - 5:00 PM	148	Model for Economic Optimization of Nuclear – Renewable Hybrid Energy Systems
5:00 PM- 5:15 PM	253	Mining representative load profiles in commercial buildings
5:15 PM - 5:30 PM	257	Viability study of stand alone hybrid energy systems for telecom base station
4:00 PM - 5:30 PM		Session 1.3 c: Waste-to-energy, Room 13, First Floor
4:00 PM - 4:15 PM	015	Exergy based comparison of two Gas Turbine Plants with Naphtha and Naphtha-RFG mixture as fuels
4:15 PM - 4:30 PM	016	Decentralized solid waste management for educational-cum-residential campus: A pilot study
4:30 PM - 4:45 PM	224	Waste to Energy: Issues, Challenges, and Opportunities for RDF Utilization in Indian Cement Industry
4:45 PM - 5:00 PM	358	Thermodynamic Studies on Steel Slag Waste Heat Utilization for Generation of Synthesis Gas using Coke Oven Gas (COG) as feedstock
5:00 PM- 5:15 PM	361	Influence Of Bed Temperature On Performance Of Silicagel Methanol Adsorption Refrigeration System At Adsorption Equilibrium
5:15 PM - 5:30 PM	363	Experimental investigation using enriched biogas in S-I engine for stable rural electrification
5:30 PM -5:45 PM	278	Biowaste Derived Highly Porous Carbon for Energy Storage
4:00 PM - 5:30 PM		Session 1.3 d: Fuel Cells, Room 14, First Floor
4:00 PM - 4:15 PM	080	Performance Study of a Anode Flow Field Design used in PEMFC Application
4:15 PM - 4:30 PM	158	Thermodynamic Analysis of a 500 MWe Coal Fired Supercritical Thermal Power Plant Integrated with Molten Carbonate Fuel Cell (MCFC) and Gas Turbine in its Flue Gas Stream
4:30 PM - 4:45 PM	266	Cellulose Nanocrystals Incorporated Proton Exchange Membranes for Fuel Cell Application
4:45 PM - 5:00 PM	267	Study of the effect of biomass derived N-self doped porous carbon in microbial fuel cell
5:00 PM- 5:15 PM	369	Numerical investigation on the influence of reactant gas concentration on the performance of a PEM fuel cell
5:30 PM - 6:30 PM	093,141,186,187,195,242,251 269,290,304,314,318,374, 378,383,384,385,387,389 391,395,399,401,404,405,410 411,412,414,415,416	Interaction over Tea for Poster Presentation, Foyer, First floor

Day 2, 11 Dec 2019

Time	Paper Id	Title
8:00 AM - 8:50 AM	Breakfast, Cafeteria, Ground floor	
9:00 AM - 10:00 AM	Invited talk	Prof. Ravi Silva, Room 21, Second floor
10:10 AM - 11:10 AM	Session 2.1 a: Fuel Cells, Room 11, First floor	
10:10 AM - 10:40 AM	Invited Talk	Prof. Prakash Chandra Ghosh
10:40 AM - 10:55 AM	169	Actuator Fault Detection and Isolation for PEM Fuel Cell Systems using Unknown Input Observers
10:55 AM - 11:10 AM	202	Modeling Polarization Losses in HTPEM Fuel Cells
10:10 AM - 11:10 AM	Session 2.1b: Electrochemical Storage, Room 12, First floor	
10:10 AM - 10:25 AM	177	Engineering of O ₂ Electrodes by Surface Modification for Corrosion Resistance in Zinc-Air Batteries
10:25 AM - 10:40 AM	258	Effect of temperature and salt concentration on the properties of electrolyte for sodium ion batteries
10:40 AM - 10:55 AM	316	Pseudocapacitive energy storage in Copper Oxide and Hydroxide Nanostructures casted over Nickel-foam
10:10 AM - 11:10 AM	Session 2.1 c: Biomass and biofuels, Room 13, First floor	
10:10 AM - 10:40 AM	Invited Talk	Prof. Sandeep Kumar
10:40 AM - 10:55 AM	308	Single particle analysis of thermally thick wood particles in O ₂ ,N ₂ [(CO)] ₂ atmosphere
10:55 AM - 11:10 AM	320	Processing thermogravimetric analysis data for pyrolysis kinetic study of microalgae biomass
11:10 AM -11:25 AM	075	Microalgae growth study with High CO ₂ Concentration stream- Experience with native species
11:25 AM -11:40 AM	108	Performance Evaluation of Gasifire Type Biomass Cookstove Models: An Experimental Study
10:10 AM - 11:10 AM	Session 2.1 d: Energy, environment, society, Room 14, First floor	
10:10 AM - 10:25 AM	021	Cooling energy saving potential of naturally ventilated interior design in low-income tenement unit
10:25 AM - 10:40 AM	105	ESCO model for energy efficient pump installation scheme: A case study
10:40 AM - 10:55 AM	178	Energy Farming - A Green Solution For Indian Cement Industry
10:55 AM - 11:10 AM	205	A non-parametric approach to investigate the effect of energy consumption on CO ₂ emissions: Evidence from a panel of South Asian countries

11:10 AM - 11:25 AM	Tea Break, Foyer, First floor	
11:30 AM- 1:00 PM	Session 2.2 a: Solar PV, Room 11, First floor	
11:30 AM - 12:00 PM	Invited Talk	Prof. Jatin Rath
12:00 PM - 12:15 PM	310	An Analysis for Management of End-of-Life Solar PV in India
12:15 PM - 12:30 PM	324	Photovoltaic Thermal Collectors with Phase Change Material for Southeast of England
12:30 PM - 12:45 PM	339	Evaluation of annual electrical energy through semitransparent (glass to glass) and opaque photovoltaic module in clear sky condition at composite climate: A comparative study
12:45 PM - 1:00 PM	351	Co-sensitization of perovskite solar cells by organometallic compounds: Mechanism and photovoltaic characterization
11:30 AM- 1:00 PM	Session 2.2 b: Nuclear Energy, Room 12, First floor	
11:30 AM - 12:00 PM	Invited Talk	Dr. Umasankari Kannan
12:00 PM - 12:15 PM	337	Development Of A Python Module “SARRA” For Refuelling Analysis of MSR Using DRAGON Code
12:15 PM - 12:30 PM	340	Current Practices and Emerging Trends in Safety Analysis of NPPs
12:30 PM - 12:45 PM	352	Nuclear Power Plants and Human Resources Development in South Asia
12:45 PM - 1:00 PM	359	Reactivity Initiated Transients for 700MWe PHWR
11:30 AM- 1:00 PM	Session 2.2 c: Transportation, Room 13, First floor	
11:30 AM - 12:00 PM	Invited Talk	Prof. A.S. Ramadhas
12:00 PM - 12:15 PM	229	Predict the Effect of Combustion Parameter on Performance & Combustion Characteristics of Small Single Cylinder Diesel Engine
12:15 PM - 12:30 PM	334	Numerical Investigation on the Effect of EGR in a Premixed Natural Gas SI Engine
12:30 PM - 12:45 PM	348	Platooning of Flat Solar Panel Mounted Mini Bus Model – A Numerical Investigation
12:45 PM - 1:00 PM	372	Design and Analysis of a Solid Oxide Electrolyser Plant for the production of Ammonia from Excess Renewable Electricity
11:30 AM- 1:00 PM	Session 2.2 d: Solar Thermal, Room 14, First floor	
11:30 AM - 11:45 AM	076	Optimization in the Operation of Cabinet Type Solar Dryer for Industrial Applications
11:45 AM- 12:00 PM	109	Transient numerical model for natural convection flow in flat plate solar collector

12:00 PM - 12:15 PM	200	Performance Analysis of Double Glass Water Based Photovoltaic/Thermal System
12:15 PM - 12:30 PM	210	Experimental study of a helical coil receiver using Fresnel lens
12:30 PM - 12:45 PM	263	A systematic investigation on evaporation, condensation and production of sustainable water from novel designed tubular solar still
12:45 PM - 1:00 PM	265	Novel design of PV integrated solar still for cogeneration of power and sustainable water using PV-T technology
1:00 PM - 1:55 PM	Lunch Break, Second floor & Cafeteria, Ground floor	
2:30 PM - 5:00 PM	Roundtable session on "Future of Coal Research", Board Room, Fourth floor	
2:00 PM - 3:30 PM	Session 2.3 a: Energy policy, economics, management + Energy Education, Room 11, First floor	
2:00 PM - 2:15 PM	089	Saving electricity, one consumer at a time
2:15 PM - 2:30 PM	146	Energy Education for sustainable future - A Review
2:30 PM - 2:45 PM	166	Bamboo Plant Intellect Deeds Optimization Algorithm for Solving Optimal Reactive Power Problem
2:45 PM - 3:00 PM	171	Analysis of Heating and Cooling Energy Demand of School Buildings
3:00 PM - 3:15 PM	221	Energy Literacy of University Graduate Students: A Multidimensional Assessment in terms of Content Knowledge, Attitude and Behaviour
3:15 PM - 3:30 PM	342	Internalizing the external cost of Gaseous and Particulate matter emissions from the coal-based thermal power plants in India
2:00 PM - 3:30 PM	Session 2.3 b: Transportation, Room12, First floor	
2:00 PM - 2:15 PM	059	Experimental Evaluation of Common Rail Direct Injection Compression Ignition Engine with EGR using Biodiesel
2:15 PM - 2:30 PM	123	Numerical Investigations on the Flow Characteristics in a Compression Ignition Engine with Vortex Tube at Inlet
2:30 PM - 2:45 PM	159	Influence of Fuel Injection Pressure and Injection Timing on Nano-Particle Emission in Gasoline/Diesel RCCI Engine
2:45 PM - 3:00 PM	204	Effect of Diesel Injection Timings on the Nature of Cyclic Combustion Variations in a RCCI Engine
3:00 PM - 3:15 PM	208	Co-axial Thermal Probe for High Frequency Periodic Response in an IC Engine Test Rig
3:15 PM - 3:30 PM	213	Optimization of Injector location on the Cylinder Head in a Direct Injection Spark Ignition Engine

2:00 PM -3:30 PM		Session 2.3 c: Solar thermal, Room 13, First floor
2:00 PM - 2:30 PM	Invited talk	Prof. Keith Lovegrove
2:30 PM - 2:45 PM	149	Exergy analysis and cost optimization of solar flat plate collector for a two stage absorption refrigeration system with water-lithium bromide as a working pair
2:45 PM - 3:00 PM	151	Design and Development of Concentrated Solar Cooker with Parabolic Dish Concentrator
3:00 PM - 3:15 PM	154	Thermal and Electrical Performance Assessment of Elongated Compound Parabolic Concentrator
3:15 PM - 3:30 PM	180	Energetic and Exergetic Performance Comparison of a Hybrid Solar Kalina Cycle at Solar and Solar Storage Mode of Operations
2:00 PM -3:30 PM		Session 2.3 d: Wind, hydro, and ocean energy , Room 14, First floor
2:00 PM - 2:15 PM	150	Experimental Investigation on Near Wake Vortex Shedding for Horizontal Axis Wind Turbine
2:15 PM - 2:30 PM	252	Numerical Investigation of the Performance of Pump as Turbine with Back Cavity Filling
2:30 PM - 2:45 PM	260	Numerical Study on CO ₂ injection in Indian Geothermal reservoirs using COMSOL Multiphysics 5.2a
2:45 PM - 3:00 PM	261	Modification in the Rotor of Savonius Turbine to Reduce Reverse Force on the Returning Blade
3:00 PM - 3:15 PM	303	Performance Assessment of Pelton Turbine with Traditional and Novel Hooped Runner by Experimental Investigation
3:15 PM - 3:30 PM	330	Performance Enhancement of Savonius Hydrokinetic Turbine with a Unique Vane Shape : An Experimental Investigation
3:30 PM - 4:00 PM		Tea Break, Foyer, First floor & Cafeteria, Ground floor
4:00 PM - 5:00 PM		Session 2.4 a: Thermal storage + Coal, Room 11, First floor
4:00 PM - 4:15 PM	061	Emission Measurement Considerations for Power Industry
4:15 PM - 4:30 PM	164	Three dimensional investigation on energy separation in a Ranque-Hilsch vortex tube
4:30 PM - 4:45 PM	226	Enhancement of Thermal Performance of ZrO ₂ Nanofluid Flow in a Tube with Staggered Conical Strip Inserts
4:45 PM - 5:00 PM	004	Determination of steam energy factor for wort kettle as a tool for optimisation of the steam energy
4:00 PM - 5:15 PM		Session 2.4 b: Grid integration of renewables + EV, Room 12, First floor
4:00 PM - 4:30 PM	Invited Talk	Prof. G. Narayanan
4:30 PM - 4:45 PM	032	Challenges, Opportunities for Demand Response Implementation on Renewable Energy and Smart Grids in India: - A Review

4:45 PM - 5:00 PM	097	Integrated Thermal Analysis of an All-Electric Vehicle
5:00 PM - 5:15 PM	128	A Novel Switched Inductor Switched Capacitor based quasi Switched Boost Inverter
4:00 PM - 5:00 PM		Session 2.4 c: Energy, environment, society, Room 13, First floor
4:00 PM - 4:15 PM	117	Enhancement in Product Value of Potato Through Chemical Pre-treatment and Drying Process
4:15 PM - 4:30 PM	302	Flow Improvement Aspect with Stagger Angle Variation of the Subsequent Rotor in Contra- rotating Axial Flow Turbine
4:30 PM - 4:45 PM	344	Electrochemical Reduction of CO ₂ On Ionic Liquid Stabilized Reverse Pulse Electrodeposited Copper Oxides.
4:45 PM - 5:00 PM	370	Energy Efficiency Analyses of a Building Envelope: A Case Study
5:10 PM - 6:10 PM		Session 2.5 a: Biomass and biofuels, Room 11, First floor
5:10 PM - 5:40 PM	Invited Talk	Prof. Pramod Kumbhar
5:40 PM - 5:55 PM	327	Modeling and Simulation of Hollow Membrane Biocatalyst Membrane Reactor
5:55 PM - 6:10 PM	329	Efficient Alkaline Peroxide Pretreatment of Sterculia foetida Fruit Shells for Production of Reducing Sugar: Effect of Process Parameters on Lignin Removal
6:10 PM-6:25 PM	331	Techno-economic Analysis for Production of Biodiesel and Green diesel from Microalgal oil
5:10 PM - 6:10 PM		Session 2.5 b: Nuclear Energy, Room 12, First floor
5:10 PM - 5:25 PM	240	Transient Analysis of Pressurizer Steam Bleed Valves Stuck Open for 700 MWe PHWRs
5:25 PM - 5:40 PM	241	Transient Analysis of Net Load Rejection for 700 MWe IPHWRs
5:40 PM - 5:55 PM	281	Orifice Enabled Flow Stabilization of Natural Circulation Loop at Lower Inclinations
5:55 PM - 6:10 PM	317	Validation of computer code based on Nodal Integral Method against KAPS-2 Phase-B data
6:10 PM - 6:25 PM	345	Performance of Flux Mapping System during spatial xenon induced oscillations in PHWRs
5:10 PM - 6:10 PM		Session 2.5 c: Microgrids and smart grids, Room 13, First floor
5:10 PM - 5:25 PM	014	Development of Power Supply to Isolated Territories of Russia Based on Renewable Energy Sources
5:25 PM - 5:40 PM	101	Multiple Distributed Generation units in Distribution Network with Change of Load
5:40 PM - 5:55 PM	138	Feedback and Feedforward Control of Dual Active Bridge DC-DC Converter Using Generalized Average Modelling
5:55 PM - 6:10 PM	256	Design, Analysis and Hardware Implementation of Modified Bipolar Solid-State Marx Generator

6:15 PM - 7:00 PM	093,141,186,187,195,242,251 269,290,304,314,318,374, 378,383,384,385,387,389 391,395,399,401,404,405,410 411,412,414,415,416	Interaction over Tea for Poster Presentation, Foyer, First floor
7:30 PM - 10:00 PM		Gala Dinner, Gulmohar Lawn

Day 3, 12 Dec 2019

Time	Paper Id	Title
8:00 AM - 8:50 AM	Breakfast, Cafeteria, Ground floor	
9:00 AM- 9:30 AM	Invited talk	A. K. Balasubrahmanian, Room 11, First floor
9:30 AM- 10:00 AM	Invited talk	Prof. Jacques Huot, Room 11, First floor
10:10 AM - 11:10 AM	Session 3.1 a: Oil and Natural Gas, Room 11, First floor	
10:10 AM - 10:25 AM	013	CMG Based Simulation Study of Water Flooding Of Petroleum Reservoir
10:25 AM - 10:40 AM	039	Fouling Mitigation in Shell and Tube Heat Exchanger through CFD Simulation
10:40 AM - 10:55 AM	086	Investigations on recovery of apparent viscosity of crude oil after magnetic fluid conditioning
10:55 AM - 11:10 AM	286	Pressure Propagation and Flow Restart in the Subsea Pipeline Network
10:10 AM - 11:10 AM	Session 3.1 b: Solar PV, Room 12, First floor	
10:10 AM - 10:25 AM	077	Modeling of Solar Photovoltaic assisted Electrolyzer-Polymer Electrolyte Membrane Fuel Cell to Charge Nissan Leaf Battery of Lithium Ion Type of Electric Vehicle
10:25 AM - 10:40 AM	121	Simulation Studies on Design and Performance Evaluation of SAPV System for Domestic Application
10:40 AM - 10:55 AM	220	Performance and Degradation Analysis of SunPower SPV modules under Composite Climatic Condition
10:55 AM - 11:10 AM	315	Localized Energy Self Sufficiency (Energy Swaraj) for Energy Sustainability and Mitigating Climate Change
10:10 AM - 11:10 AM	Session 3.1 c: Energy, environment, society, Room 13, First floor	
10:10 AM - 10:25 AM	133	Addressing Last Mile Electricity Distribution Problems: Study of Performance of SHGs in Odisha
10:25 AM - 10:40 AM	248	Effect Of Non-Revenue Water Reduction In The Life Cycle Of Water-Energy Nexus: A Case study
10:40 AM - 10:55 AM	294	Design and development of an economical and reliable Solar Powered Trash Compactor
10:55 AM - 11:10 AM	031	Techno-Economic Optimization Of Isolated Hybrid Energy System
10:10 AM - 11:10 AM	Session 3.1 d: Solar thermal, Room 14, First floor	
10:10 AM - 10:25 AM	102	Novel synthesis of Al ₂ O ₃ nanoflakes for Ni-Al ₂ O ₃ composite solar selective coatings
10:25 AM - 10:40 AM	296	Techno-economic analysis of solar tri-generation system based concentrated photovoltaic/thermal collector

10:40 AM - 10:55 AM	307	An Experimental and CFD analysis on Heat Transfer and fluid flow characteristics of a tube equipped with X-shaped tape insert in a U-shaped heat exchanger
11:10 AM - 11:25 AM	Tea Break, Foyer, First floor & Cafeteria, Ground floor	
11:30 AM- 1:00 PM	Session 3.2 a: Grid integration of renewable, Room 11, First floor	
11:30 AM - 11:45 AM	064	Impact of Growing Share of Renewable Energy Sources on Locational Marginal Prices
11:45 AM - 12:00 PM	135	Transient Stability Analysis of Wind Integrated Power Network using STATCOM and Battery Energy Storage System using DIgSILENT Power Factory
12:00 PM - 12:15 PM	239	Dynamic Demand Response through Decentralized Control of Resources
12:15 PM - 12:30 PM	250	Improved Dispatchability of Solar Photovoltaic System with Battery Energy Storage
12:30 PM - 12:45 PM	305	Evaluation of LVRT Control Strategies for Offshore Wind Farms
12:45 PM - 1:00 PM	318	Bi-Polar DC Micro Grid based Wind Energy System
1:00 PM - 1:15 PM	284	Voltage regulation and loss minimization in distribution systems with capacitors and OLTC in presence of a PV penetration.
11:30 AM- 1:00 PM	Session 3.2 b, Thermochemical and hydrogen storage, Room 12, First floor	
11:30 AM - 12:00 PM	Invited Talk	Prof. Yoshitsugu Kojima
12:00 PM - 12:15 PM	116	Effect of Temperature on the Hydrodynamics of Steam Reactor in a Chemical Looping Reforming System
12:15 PM - 12:30 PM	172	Thermodynamic performance analysis of adsorption cooling and resorption heating system
12:30 PM - 12:45 PM	181	Enhanced Reversible Hydrogen Storage in Palladium Hollow Spheres
11:30 AM- 1:00 PM	Session 3.2 c, Solar thermal, Room 13, First floor	
11:30 AM - 11:45 AM	114	Technological Interventions in Sun Drying of Grapes in Tropical Climatic for Enhanced and Hygienic Drying
11:45 AM - 12:00 PM	338	The effect of Concentrator ratio and Thermocouples on Photovoltaic-Thermoelectric Hybrid Power Generation System
12:00 PM - 12:15 PM	360	Multi-Field Solar Thermal Power Plant with Linear Fresnel Reflector and Solar Power Tower
12:15 PM - 12:30 PM	364	Solar autoclave for rural hospitals using aerogel as transparent insulation material
11:30 AM- 1:00 PM	Session 3.2 d, Solar PV, Room 14, First floor	
11:30 AM - 11:45 AM	074	Adaptive Relaying Scheme for a Distribution Network with Highly Penetrated Inverter Based Distributed Generations

11:45 AM- 12:00 PM	211	Substrate-assisted electrosynthesis of patterned lamellar type indium selenide (InSe) layer for photovoltaic application
12:00 PM - 12:15 PM	285	P-type Crystalline Silicon Back Surface Passivation using Silicon Oxynitride/SiN Stack for PERC Solar Cell Application
12:15 PM - 12:30 PM	300	Performance Analysis of Hybrid Photovoltaic Array Configurations under Randomly Distributed Shading Patterns
12:30 PM - 12:45 PM	335	Transitions in the Indian Electricity Sector: Impacts of High Renewable Share
12:45 PM - 1:00 PM	347	Forecasting of Electricity Demand and Renewable Energy Generation for Grid Stability
11:30 AM- 1:00 PM	Session 3.2 e, Wind, hydro, and ocean energy, Room 15, First floor	
11:30 AM - 11:45 AM	009	Wind Speed Forecasting using k-Nearest Neighbour Method for Three Locations in Maharashtra, India
11:45 AM- 12:00 PM	022	Resilience of PV glass coatings to cleaning processes
12:00 PM - 12:15 PM	049	Simulation of Horizontal Axis Wind Turbines using NREL FAST
12:15 PM - 12:30 PM	094	Performance Assessment and Loss Forecasting of Grid Connected Solar PV System
12:30 PM - 12:45 PM	183	Design and Analysis of Hybrid Vertical Axis Giromill Wind Turbine
1:30 PM - 1:55 PM	Lunch Break, Second floor & Cafeteria, Ground floor	
2:00 PM - 3:30 PM	Session 3.3 a, Industry presentations, Room 11, First floor	
2:00 PM - 3:30 PM	Session 3.3 b, Industry presentations, Room 12, First floor	
3:30 PM - 4:00 PM	Tea Break, First floor foyer	
4:00 PM - 5:30 PM	Panel Discussion	Energy Transitions and Energy Security, Main Auditorium, Ground floor
5:30 PM - 6:00 PM	Awards and Concluding Ceremony, Main Auditorium, Ground floor	

Invited Talks

Mr. Homi Nariman Daruwalla

Head, CII Maharashtra Energy and Environment Panel
Head, CII Taskforce on Improvement for Facilitation and
Consultancy Services of Green Building



Biography

Mr. H. N. Daruwalla heads the CII IGBC Consultant Rating Committee. He is a Green Assessor and a member of CII IGBC Railway Rating Committee. He also heads CII Taskforce on Improvement for Facilitation and Consultancy Services of Green Building and the CII Maharashtra Energy and Environment Panel.

He completed his matriculation from Boys' Town, Nasik, Inter Science from Ruparel College, Mahim and Electrical Engineering from The Walchand College of Engineering, Sangli. He joined the Electricals & Electronics Division of Godrej & Boyce Mfg Co Ltd, in the year 1970 as an Engineer and was responsible for transforming the erstwhile Electrical Department which looked after the Electrical Distribution Network of Godrej, Vikhroli into diversified services in Electrical, Electronics, Air conditioning, Air Compressors, Communications and Energy Conservation.

He retired in September 2015, as Executive Vice President and Business Head of the Electricals & Electronics Division which was engaged in Diversified Businesses as: Compressed Air Solutions, Industrial Electronics & Automation, Power Distribution Solutions, Turnkey Electrical Contracts & Green Business Consultancy Services.

He was keenly interested in implementing Energy Conservation measures in the Company and was responsible for implementation of majority of the Energy Conservation projects in all the Plants of Godrej & Boyce Mfg. Co. Ltd.

He was driving MSG (Mission on Sustainable Growth) throughout the Organization as part of CSR (Corporate Social Responsibility) "GREENER INDIA" wherein we have targeted reduction in specific Energy Consumption, specific Water Consumption and reduction in Waste Generation over next 10 years.

He has also organized many conferences on Energy Conservation and Energy Management for CII Maharashtra and CII Western Region. His field of interest is Green Building Business. Apart from being actively involved in putting up CII-Sohrabji Godrej Green Business Centre at Hyderabad, which is the first Platinum Rated Building outside US, Mr Daruwalla is also a LEED Accredited Professional, United States Green Building Council (USGBC) and a member of the Accreditation Panel of BEE, to certify Energy Managers, Energy Auditors and Electrical Audit Firms.

Prof. Diana Ürge-Vorsatz,
Department of Environmental Sciences and Policy
Central European University
Hungary



Biography

Prof. Diana Ürge-Vorsatz is a Professor at the Department of Environmental Sciences and Policy, Central European University, Hungary and the Director of the Center for Climate Change and Sustainable Energy Policy (3CSEP). She is also the Vice Chair of Working Group III of the Intergovernmental Panel on Climate Change (IPCC) and has been a Leader for Scientific review of Sustainable Development Goal “7” in the new UN Development goals development process (“Ensure access to affordable, reliable, sustainable, and modern energy for all”). She has worked extensively in the areas of energy efficient buildings and climate and energy policy.

Prof. Ravi Silva

Advanced Technology Institute,
University of Surrey,
Guildford GU2 7XH, United Kingdom.
s.silva@surrey.ac.uk



Biography

Prof. Ravi Silva is a Surrey Distinguished Professor and the Director of the Advanced Technology Institute (ATI) at the University of Surrey. He heads the Nano-Electronics Centre (NEC). Prof. Silva conducted his studies at Cambridge University. He is the inventor of 30 patents and two start-up companies. He is the 2014 winner of the J J Thomson Medal from the IET for contributions to electronics, in 2015 the winner of the Platinum Medal from the IOM3, in 2018 the winner of the James Joule Medal from the Institute of Physics and has won numerous international awards for research. He is a Fellow of the Royal Academy of Engineering and National Academy of Sciences Sri Lanka.

Talk: Solar power for a cleaner future: Transitioning to free energy by 2035?

Energy generation processes at the supply-end worldwide is going through major change. The dominance of fossil fuel based energy generation is being challenged, and this is predominantly due to cheaper renewables coming to the market. What happens with the steady progress being made in the organic-inorganic large area compatible plastic electronic technologies as well as the tandem silicon-perovskite era? Will we see a complete overhaul of the system by 2035?

Within the talk novel technologies being progressed using 4G (4th Generation) solar cells that include perovskites will be discussed and show how these will all develop into a very interesting decade of technology development in flexible organic electronics as part of the energy mix. The routes for higher efficiency organic cells, while maintaining the low cost base will be discussed. The use of novel architectures and materials will include perovskites. We will focus on a solvent engineering-based approach that enables parasitic Sn⁴⁺ produced by oxidation of Sn²⁺ in Sn-based perovskite solar cells (PSCs) to be removed. The resulting process, motivated by work in ores and alloys, through appropriate solvent selection enables the highest grain sizes, low Urbach energies and high charge carrier mobilities, for the triple cation Pb-Sn mixed Cs_{0.05}(FA_{0.83}MA_{0.17})_{0.95}Pb_{0.5}Sn_{0.5}I₃ (bandgap~1.26 eV) system . The resulting PSCs enable more than 80% improvement in device efficiencies compared to other anti-solvents that extract Sn⁴⁺ less efficiently with champion efficiencies exceeding 12%. Furthermore, a route towards fill factors exceeding 80% with a best value of 83% approaching the Shockley-Queisser limit will be discussed through the incorporation of Br- .

The need for flexible energy scavenging sources as well as novel energy storage ensures “energy materials” will be at the heart of any new technologies to be introduced and developed in the coming years. The current drivers for energy security and energy mix will be analysed, and question why humanity appears to be stuck on fossil fuels. In the future is it possible that the paradigm of paying for electricity can be overturned and even enter a process where we are able to give free energy by 2035? We will examine the potential of energy scavenging to supply all energy needs for society, including wearables and if this can be realised at zero cost to the consumer.

Shri. A. K. Balasubrahmanian

Director (Technical)

Nuclear Power Corporation of India Limited (NPCIL), India



Biography

Shri A. K. Balasubrahmanian is a Mechanical Engineering Graduate from Regional Engineering College (now NIT), Kozhikode. After completing one year orientation course in Nuclear Science and Engineering from BARC Training School (28th Batch), he joined the erstwhile Nuclear Power Board (now NPCIL) under the Department of Atomic Energy in 1985. He has about 33 years experience in Design, Development, Engineering, Pre-project studies, Design co-ordination, Safety Review, Stress Analysis & Seismic qualification, Procurement, Construction and Commissioning of Nuclear Power Plants. He is credited with design, development and implementation of First of a kind Reactor Control & Shutdown systems for TAPS-3&4. He is equally versatile in PHWRs and LWRs, having worked in design & engineering of these reactor systems. He has participated in the preparation of Regulatory Codes and has been instrumental in obtaining Regulatory Consents & Clearances for various projects. He has experience in technical discussions with International reactor vendors.

Shri Balasubrahmanian has made significant contributions in the implementation of 220 MW, 540 MW & 700 MW PHWR projects and 1000 MW PWR (KKNPP) in the areas of his expertise. He has made extensive contributions in safe and continued operation of PHWR based stations, particularly in the area of coolant channels. Shri Balasubrahmanian has been conferred with NPCIL Technical Excellence Award and a number of other NPCIL awards in recognition of his outstanding contributions to the Nuclear Power Programme.

Shri A.K. Balasubrahmanian is a Distinguished Scientist of the Department of Atomic Energy. Prior to taking over as Director (Technical) on 14th August 2018, he was working as Executive Director (Engineering) with the overall responsibility of design & engineering of PHWRs and procurement of Reactor core components, Fuel and Fuel Handling components. He is also a Member of the Board of Management of Heavy Water Board and Director in NPCIL-NALCO Power Company Ltd.

Dr. A.S. Ramadhas

Senior Research Manager
Indian Oil Corporation Limited, R&D Centre
India
ramadhasas@indianoil.in



Biography

Dr A.S. Ramadhas is currently a Senior Research Manager in Vehicle Testing, Fuels and Emissions Department, of R&D centre of Indian Oil Corporation Ltd, India. He has 15 years of experience in the field of conventional & alternative fuels, fuel additives and emissions research. He received his PhD in Mechanical Engineering from National Institute of Technology Calicut in 2007. He was awarded with Marie Curie Fellowship from European Commission for his post doctoral research at University of Birmingham, UK during the year 2013-14.

He authored 50 technical papers in the peer-reviewed international journals and conferences; a patent on process improvement to enhance cetane number. He edited and authored a book on Alternative Fuels for Transportation which was published by Taylors & Francis, USA in 2010. He is a member of BIS panel for M15 (15% methanol blended gasoline) fuel specification and Combustion committee and Conference organizing committee member of SAE International, USA.

Talk: Fuel economy thru' Fuels and Lubricants

Fuel economy is highly pronounced in recent years as it is directly with exhaust emissions and fuel consumption or energy security of a nation. Fuel economy can be enhanced through the upgradation in engine design/ technologies, use of fuel additives and low viscosity engine oils. During the mileage accumulation carbon deposits formed and accumulated on engine intake valves in the case of MPFI vehicles and absorb/desorbs fuel vapours and hence reduce fuel economy and increase emission. In GDI vehicles and CRDI vehicles the injector holes clogged with deposits and affect the spray pattern. Moreover, CRDI vehicles internal injector components are also subjected to deposit formation and affect the power generated. The detergency additives are doped in fuels to keep clean/ clean up the engine components so that vehicle performance is maintained for a longer period of time. The fuel economy of vehicle can be improved by using low viscosity engine oils without comprising the durability. This presentation covers standard engine and vehicle test methods practiced by oil marketing companies, auto industries and additive manufacturers to evaluate the fuel economy during the mileage accumulation.

Prof. Carlos Alberto Dorao

Department of Energy and Process Engineering
Norwegian University of Science and Technology (NTNU)
Norway
carlos.dorao@ntnu.no



Biography

Prof. Carlos Alberto Dorao was born in Aguilares (Tucumán), Argentina. I have an engineering degree in Nuclear Engineering from Balseiro Institute, Argentina, and a Ph.D. degree in Chemical Engineering from NTNU. His research interests cover heat and mass transfer issues related to the development of more efficient processes, and multiphase and multicomponent separation issues related to the oil and gas industry.

Talk: New understanding of the heat transfer mechanisms in two phase flows

While single-phase flow is well understood or at least the models can predict the heat transfer with good level of accuracy, the complexity attributed to two-phase flows has limited the possibility of achieving models which are even close to the levels of accuracy achieved for the ones in single-phase flow. During the past few decades, heat transfer in two phase flow systems have been widely studied with the goal of unveiling the physics of the process for being able to improve the level of accuracy of the models. Different heat transfer mechanisms have been suggested based on different assumptions which has resulted in a large number of models including different dimensionless numbers and, in some cases, up to a dozen of adjusted parameters. In this presentation the similitude between the heat transfer in single phase flow and in two phase flow without vapour generation at the wall will be discussed. This suggested similitude can help to reduce the complexity of the prediction of the heat transfer in two phase flow systems.

Prof.G. Narayanan

Chairman

Department of Electrical Engineering

Indian Institute of Sciences, Bangalore

India

gnar@iisc.ac.in



Biography

Prof. G. Narayanan currently works at the Department of Electrical Engineering, Indian Institute of Science. He conducts research in the areas of power electronics, electric machines, motor drives, high power converters and power semiconductor devices.

Prof. Jacques Huot
Hydrogen Research institute
Univ. du Québec à Trois-Rivières
3351 des Forges, Trois-Rivières, Québec,
G9A 5H7
Canada



Talk: Fundamental aspects of synthesis of metal hydrides

Hydrogen as an energy vector will play an increasing role in the future. It can be coupled to renewable energy sources (wind, solar) and is a perfect partner for electricity as it could be produced by it using an electrolyzer or generate electricity from a fuel cell. One of the problems that has to be solved for the full development of a hydrogen economy is the safe and efficient storage of hydrogen. Presently gaseous and liquid storage are the choices solutions but for many applications other means of storage is needed. Metal hydrides are considered to be excellent candidates for hydrogen storage applications because of their high hydrogen volumetric densities (sometimes higher than in liquid hydrogen) and the possibility to absorb and desorb hydrogen with a small change of hydrogen pressure. In this presentation we will discuss about the recent results on the fundamental aspects of synthesis of metal hydrides. Two different types of metal hydrides will be presented: Laves phase AB_2 and TiFe alloy.

Prof. Jatin Rath

Department of Physics
Indian Institute of Technology, Madras
India



Talk: Controlling dusty plasma: A key to fabrication of silicon based solar cells

Photovoltaics is now a serious option for sustainable power supply and in many countries solar power has reached grid parity. Silicon based solar cells have reached efficiencies (26.7%) near to the theoretical Shockley-Queisser limit and “Passivating Contact Cells”, especially silicon heterojunction type of cells are considered to be the next generation towards commercialization after the current trend of PERC type cells. Though Si wafer based PV controls almost 90% of the market, various options, such as large area and rollable modules on metal foils and cheap plastics are at various stages of commercial manufacturing. PECVD is the conventional fabrication tool for the silicon layers and more-often-than-not a low temperature processing is used.

Dusty plasma is generally encountered while low temperature processing of silicon based device using silane gas. Fabrication of various types of solar cell use low temperature processing, namely, silicon heterojunction cells, thin film silicon solar cells on plastics and temperature sensitive substrates and quantum dot based solar cells, representing 1st, 2nd and 3rd generation solar cells respectively. However, the tolerance to a dusty regime of growth widely varies for these three cases, from extremely low in 1st case to desirable in 3rd case. Various in-situ plasma and gas phase diagnosis tools, such as Mass Spectrometer, Retarding Field Energy Analyzer, Plasma V-I probe, Optical Emission Spectrometer have been used to identify the dusty, non-dusty and nanocrystalline growth regimes. Such a study showed clearly that a very narrow regime of growth exists for amorphous silicon that avoids both dust in plasma and local epitaxy on silicon substrate, the necessary conditions for device quality silicon heterojunction, and life time in excess of 10 ms is achieved, leading to more than 17% efficiency even on plane wafers. Controlling ion energy seems to be an additional vital parameter for the thin film silicon solar cells on plastics, which can be achieved by a strategic combination of plasma power and pressure. Efficiency more than 7% is achieved even on cheap PET and PC plastics. For quantum dots fabrication, dusty regime is allowed to progress up to the condition when the particles of quantum size is reached and particles are pulled out of plasma zone towards the substrate, by employing a combination of pulsed power and thermophoresis effect. Quantum sized nearly mono dispersed silicon and SiGe particles are obtained by this technique.

Dr.Keith Lovegrove

IT Power
Australia



Biography

Keith is a leading expert in concentrating solar power (CSP). He has more than 30 years' experience in solar energy combined with 15 years of teaching experience in undergraduate and postgraduate courses in Energy Systems and Systems Engineering. He has worked extensively on the storage of solar energy with hydrogen and ammonia. He was previously the leader of the Solar Thermal Group at the Australian National University. In that role he was the lead inventor and design and construction team leader of the 500m² (world's largest) Generation II Big Dish solar concentrator.

Keith has a Bachelor of Science (First Class Honours) and PhD from the Australian National University. He has represented Australia as International Energy Agency (IEA) Solar PACES (Power and Chemical Energy Systems) Solar Chemistry task representative over many years and currently is the alternative executive committee representative. In 2012, he was a Member of the Australian Prime Minister's Science, Engineering and Innovation Council, Expert Working Group on Climate Energy and Water Links. He is a member of the University of Adelaide's Centre for Energy Technology advisory board, board member of the Australian Solar Thermal Association and also serves on the Australian Renewable Energy Agency's advisory panel.

Talk: Concentrating solar thermal – a key dispatchable renewable option

The global deployment of wind and PV renewable electricity generation continues to beat all past projections. However variable generation can not meet all our electricity needs. If the world is to meet the Paris climate goals of limiting global warming to no more than 2 °C, complete decarbonization needs to be achieved by around 2050. Workable electricity systems need a significant fraction (30-50%) of the generation to be from dispatchable generators. That is generators which can have their level of output determined at will by the system operator. Studies in Australia show that there are multiple options for achieving this, either via storage or electricity or via inherently dispatchable technologies. One of the key options is Concentrating Solar Power. Almost all CSP power plants now being installed incorporate thermal energy storage for around 6-15 hours of operation. Two tank molten salt energy storage is now the standard and proven approach. Although only 2% the size of the PV industry, CSP deployment continues to grow strongly. This talk will review the trends around the world. Overall efforts in all countries need to be made to accelerate the uptake of dispatchable options like CSP if a fully balanced zero emissions system is to be established in a smooth manner by 2050.

Prof. Pradip Dutta

Chairman, Department of Mechanical Engineering,
Indian Institute of Sciences (IISc), Bangalore
India



Biography

Prof. Dutta received his BTech from IIT Kharagpur in 1983, M. Tech from IIT Madras in 1987, and Ph.D. from Columbia University in 1992, all in Mechanical Engineering. Prof. Dutta's research group focuses on the development of advanced energy technologies related to solar energy, cooling of electronics, spacecraft thermal management, and on thermal technologies related to phase change.

Prof. Dutta has been elected Fellow of the ASME, and Fellow of all the four National Academies in science and engineering. Among his several awards, he has received Distinguished Alumnus Awards both from IIT Kharagpur and IIT Madras, and the Outstanding Teacher Award from the Indian National Academy of Engineering. He is a J.C. Bose National Fellow, awarded by the Department of Science and Technology. Currently, he is the President of the Indian Society for Heat and Mass Transfer (ISHMT).

Talk: High Temperature Receivers and Thermal Storage Systems for Concentrating Solar Power

The demand for distributed and scalable solar thermal power plants necessitates the use of novel power cycles which are efficient and cost effective at low to medium scales. For regions pertaining to high insolation intensities, the supercritical CO₂ based Brayton cycle is now recognized to be a suitable candidate, having potential to yield high efficiencies at moderate operating temperatures of about 700 °C. However, development of components for such power cycles, such as solar receivers, recuperators and storage systems involve significant materials as well as heat transfer challenges which are highlighted in the present paper. Various solar receiver configurations and some recent advances in development of high temperature CO₂ receiver are presented. High temperature thermal storage materials such as molten salt and ceramic-based porous honeycombs, and the associated thermal systems are also discussed.

Dr.Pramod Kumbhar

Praj Matrix
India



Biography

Dr. Kumbhar is working with Praj Industries, as President and Chief Technology for last 8 years at Praj Matrix–R&D center leading 90+ scientists and engineers. After working for 20+ years in petrochemical (hydrocarbon) industry made a shift to biotechnology led renewable fuels and chemicals industry. Focused on driving innovations in biotechnology to make biofuels and bio chemicals. Ph.D. in Chemical Engineering from Institute of Chemical Technology (formerly UDCT), Mumbai. Post-doctoral stints at CNRS laboratories in Montpellier and Institute of Catalysis, Lyon in France. Fellow of Maharashtra academy of sciences. Received the ICI process development award from Indian Institute of Chemical Engineers. Worked at General Electric R&D Centre in Bangalore and SI Group (formerly Schenectady chemicals, USA) in various positions including last assignment as R&D director for Asia Pacific. 30+ International patents and 25+ publications in peer reviewed scientific journals. Received Bronze and silver medals from GE for patent filings.

Talk: Unlocking Biomass Energy: Process Development and Scale-up of Biomass Conversion to Advanced Fuels

The sustainable production of both biofuels and bioproducts depends largely on the efficient and cost effective access to biomass conversion technologies. Due to the physical and chemical complexities of plant based biomass, the conversion process typically includes thermochemical pretreatment, enzymatic saccharification and microbial fermentation. This presentation will highlight the process development we have demonstrated in converting different types of biomass to fermentable sugars and fuel intermediates through various approaches. The scaling up challenges associated will be addressed. An overview of the technologies and substrate accessibility via efficient biomass utilization will be summarized. Both technical and economic challenges of the conversion process will be discussed to provide some perspectives for future process development and optimization.

Dr.Umasankari Kannan

Head , Reactor Physics Design Division
Bhabha Atomic Research Centre (BARC)
India



Biography

Dr. Umasankari Kannan is heading the Reactor Physics Design Division of Bhabha Atomic Research centre and has a vast experience spanning 33 years in the field of Reactor Physics. She is also a senior professor in Homi Bhabha National Institute (HBNI). She is responsible for the for the design of thorium fuelled Advanced Heavy Water Reactor (AHWR), Indian Pressurized water reactor (IPWR) and advanced thermal reactors such as High temperature reactors and Molten salt breeder reactors. She has many notable contributions to the physics design for AHWR and IPWR. She is also leading the team for experimental reactor physics activities and irradiation in reactors and other facilities. Her areas of specialization include, thorium utilization, Nuclear Data Physics for the thorium fuel cycle, fuel cycle studies for advanced systems. She has also contributed to irradiation experiments, analysis of existing reactors and providing reactor physics support to reactor safety.

Her research focus is in thorium fuelled reactor design, fuel cycle studies and development of new methods and codes. As a faculty at the HBNI, she is regularly engaged in teaching and is guiding many PhD students in the files of Reactor Physics and Nuclear Engineering. She has over 400 publications including 72 papers in peer reviewed Journals and International conferences and 6 technical articles on thorium utilization.

Talk: Design approach towards enhanced fuel utilisation and inherently safe nuclear energy systems

Nuclear energy as a clean and safe energy source has been successfully established. However, the energy potential of the available nuclear reserves has not been fully exploited. Uranium in light water systems is still the main workhorse of today's nuclear reactors. Advanced fuel cycles are based on enhanced fuel utilisation where energy extraction per tonne of mined uranium is a major criterion. The energy potential can be significantly increased by using a closed cycle option by recycling the plutonium generated in spent fuel. Thorium as a carrier is a good candidate for plutonium recycles. The other most important factor is safety. Current and future generation nuclear reactors are designed to be very robust and have to demonstrate safety at several levels. The passive safety features and high burnup of the thorium based Indian Advanced Heavy Water Reactor (AHWR) is a good example of design approach of the new reactors. The design goals are elucidated in the GEN-IV systems and the IAEA INPRO platforms. Several reactor concepts are being developed with these redefined objectives. This talk will focus on the design philosophy of advanced reactor systems, especially with respect to inherent safety, integrated fuel cycle, need for newer materials, requirement of better analysis tools and experimental validation.

Prof. Yoshitsugu Kojima

Natural Science Center for Basic Research and
Development
Hiroshima University
Japan
kojima@hiroshima-u.ac.jp



Talk: Hydrogen Storage Materials for Renewable Energy Uptake

Hydrogen can store renewable energy and it is produced by electrolysis of water and thermochemical water splitting. Unfortunately, energy density of hydrogen is low because of gas at room temperature. Therefore, we need hydrogen storage materials (hydrogen carriers) to take in renewable energy for global leveling. We have evaluated and analyzed 200 kinds of hydrogen storage materials such as hydrogen storage alloys, inorganic chemical hydrides, liquid hydrides, and carbon materials from the same perspective. We found that Ammonia (NH₃) is easily liquefied by compression at 1 MPa and 298 K, and has a highest volumetric hydrogen density of 10.7 kg H₂/100 L. It also has a high gravimetric hydrogen density of 17.8 wt%. Thermodynamically NH₃ is unstable compound and the theoretical hydrogen conversion efficiency is about 90%. NH₃ is produced from hydrogen and nitrogen by Haber–Bosch process. Current proton exchange membrane (PEM) fuel cells are poisoned even by trace level (about 1ppm) of NH₃. We have found that high purity hydrogen fully satisfied hydrogen fuel specifications for fuel cell vehicles (NH₃=0.1ppm, N₂=100ppm, H₂=99.97%) can be produced from NH₃ by the system combined NH₃ cracker including catalysts, NH₃ remover including zeolite and H₂ purifier with pressure swing adsorption (PSA) method.

Abstracts

003

Investigation on the effect of Magnetic Field Assisted Combustion on the Performance and Emission Characteristics of a multi cylinder Spark Ignited Engine
Libin P. Oommen^{1*} and Kumar G. N²
^{1,2}National Institute of Technology Karnataka, Surathkal, India

*libinpanavelil@gmail.com

This study investigates the effect of magnetic fields of varying intensities on enhancing the combustion properties of hydrocarbon fuels. Experiments were conducted on a multi cylinder MPFI spark ignited engine fueled with commercially available gasoline. High grade NdFeB magnets were used to vary the intensity of magnetisation from 3200 Gauss to 6400 Gauss and the respective effects on the performance and emissions of the engine were studied. Performance of the engine was evaluated on the basis of specific fuel consumption, brake power and brake thermal efficiency. The consumption of fuel reduced up to 13.8% at a magnetic intensity of 6400 Gauss. It was also observed that the percentages of exhaust components like carbon monoxide and UBHC showed a reduction up to 23.9% and 13.1 % respectively. The results are validated and discussed based on prior works in this area.

004

Determination of steam energy factor for wort kettle as a tool for optimization of the steam energy
Shripad Kulkarni¹, Alex Bernard¹
¹ Department of Research and Development, Forbes Marshall Pvt Ltd, Pune – 4110034, INDIA
lncs@springer.com

Increased focus on sustainability and energy conservation in process industries has led to a tremendous shift towards energy savings through reduced steam consumption. Evaluation of steam energy utilization by determining the SEF (steam energy factor) for energy intensive equipment in a Brewhouse such as the Wort kettle helps to demonstrate the potential for a substantial reduction in steam consumption. The high steam demand in Brewhouse is often subjected to change due to various factors and conventional techniques to estimate steam requirement might not be adequate to capture this versatility. The study proposes a methodology for determining the SEF for Wort kettle. A Machine Learning enabled model is developed taking into account all the critical factors that primarily influence the steam energy requirement in a Brewhouse. The model was incorporated into our cloud based platform and installed at major Breweries across India. Initial analysis done for 400HL and 440HL batches emphasized the parametric sensitivity of the model that subsequently characterized the various losses occurring in the Wort kettle and also the effect of each of the process parameters on steam energy requirement. Wort kettle running at sweet wort composition of less than 34% having an SEF of 1.76 accounted for 27% evaporation loss, 8.2% condensate loss, 2.4% flash loss, 1.3% heat recovery loss and 6.4% miscellaneous loss. The model helped establish relationship between the losses and all the process parameter which helped in optimizing the process control. The average SEF value was reduced from 1.76 to 1.6 with better control strategy achieved through SEF that translated to a reduction in average steam consumption of 5371 Kg/brew to 4720 Kg/brew within 7 months. Further optimization of the model overtime may help in achieving an SEF value of 1.58 with massive reduction in energy requirement.

008

Control Analysis of Modular Multilevel Converter by using Different Modulation Technique**Rahul Jaiswal^{1*}, Anshul Agarwal² and Richa Negi³**¹Department of Electrical Engineering, MNNIT Allahabad, Prayagraj, India;²Department of Electrical & Electronics Engineering, NIT Delhi, Delhi, India;³Department of Electrical Engineering, MNNIT Allahabad, Prayagraj, India,

*ree1651@mnnit.ac.in

The performance of modular multilevel converter by using different multicarrier modulation technique has been analyzed in this paper. The voltage and current performance of modular multilevel converter has been shown. The alternate phase opposition disposition (APOD), carrier overlap (CO) and phase shifted (PS) pulse width modulation (PWM) technique have been studied. A comparative analysis of modular multilevel converter has also been done by using APOD, CO and PS modulation technique at different modulation index and fixed carrier frequency. This analysis shows that the phase shifted modulation technique is one of the best techniques as compared to other technique. It has been observed that the total harmonic (THD) has been improved by using phase shifted modulation technique. All the results have analyzed and verified by Matlab/Simulink.

009

Wind Speed Forecasting using k - Nearest Neighbour Method for Three Locations in Maharashtra, India**Parikshit G. Jamdade^{1*}, Karan J. Pawar², Sachin R. Patre³, Ashish C. Wadile⁴, Vedant V. Wanjarkheadkar⁵ and Shrinivas G. Jamdade⁶**^{1,2,3,4,5}Department of Electrical Engineering, PVG's College of Engineering and Technology, Pune, Maharashtra, India⁶ Department of Physics, Nowrosjee Wadia College, Pune, Maharashtra, India

*parikshit_jamdade@yahoo.co.in

Due to immense increasing agricultural and industrial activities in India, the load demand is also increasing. To reduce dependency on fossil fuels, currently India is shifting towards use of renewable energy sources like solar, wind. As wind speed and wind direction is random in nature, the correct long-term and short-term forecasting of wind speed is absolutely necessary for knowing the wind power generation availability. In this study we are using k - nearest neighbours (kNN) nonparametric regression method for wind speed prediction by using historical wind speed data. Wind speed raw data measured by Indian Meteorological Department, Pune for three locations in Maharashtra state, India has been used to carry out this analysis. The coding and simulations were carried out with help of C++ software. It is observed that the mean error (ME) by kNN for Pune, Nashik and Ahmadnagar locations are around 0.125, 0.079 and 0.069 respectively. Results show that the accuracy of the used method is over 90 - 95 percent.

012

Production and Performance Evaluation of Biomass Briquettes Produced with Waste Sugarcane Bagasse and Cow Dung for Sustainable Development**Anupriya Gupta^{1*} and Deepak Sharma²**¹Ph.D Scholar, ²Professor, Department of Renewable Energy Engineering, CTAE, MPUAT, Udaipur.

*anayagupta18@gmail.com

Sugarcane is among the principle agricultural crops cultivated in tropical countries. The annual world production of sugarcane is ~1.6 billion tons, and it generates ~280 MMT of biomass residues. Agricultural waste management during processing is one of the most serious rural-urban environmental problems in India. The efficient utilization of sustainable resources will assist in improving the socioeconomic status of developing countries, creating employment opportunities and improving the environment. In this study, binder less briquettes were produced from sugarcane bagasse and cow dung mixture using hand operated briquetting machine. Different treatments of briquettes were produced with these raw materials in the ratio of 50: 50(treatment 1), 55: 45(treatment 2) and 60: 40(treatment 3) sugarcane bagasse and cow dung respectively. The results of the performance evaluation tests showed that the density of treatment 1 was 0.15 gm/cm², treatment 2 was 0.1 gm/cm² and treatment 3 was 0.08 gm/cm². The moisture content was in the range of 6 – 6.5 %. The ash content of the briquettes were 5.3, 5.9, 6.2 % , the fixed carbon content 19.7, 18.1, 14.8 % and volatile matter was 75, 76, 80 % of treatment 1, 2 and 3 respectively. The shatter resistance of briquetted fuel was 93, 88, 78% of treatment 1, 2 and 3 respectively. The study also revealed that the CV and thermal efficiency of treatment 3 (60:40) briquettes was highest i.e. of 4280 kcal/kg and 25 % respectively.

013

CMG Based Simulation Study of Water Flooding Of Petroleum Reservoir**Pratiksha D. Khurpade^{1*}, Somnath Nandi^{2**}, Pradeep B. Jadhav³ and Lalit K. Kshirsagar⁴**^{1,3,4}Department of Petroleum and Petrochemical Engineering, Maharashtra Institute of Technology, Paud Road, Pune – 411 038, INDIA²Department of Technology, Savitribai Phule Pune University, Ganeshkhind, Pune – 411 007, INDIA
*pratiksha.kale@mitpune.edu.in, **somnath.nandi11@gmail.com

In petroleum industry, water flooding is used as secondary recovery method to increase the oil production. It is most widely used and popular method due to easy water availability, ease of injection, and mobility etc. but at later stages it becomes uneconomical due to cost of separation and treatment of the produced water. Hence, in order to maximize the oil recovery in an economical way from waterflooding, it is important to make some changes in the flooding pattern. The aim of the present study is to analyze the waterflooding performance for the enhancement of oil production of virtual reservoirs using CMG-IMEX (Computer Modeling Group) reservoir simulation tool. The performance analysis is done for different flooding layout (horizontal or combination of vertical and horizontal well) and of different length of injection and production well. Three parameters such as cumulative oil production, percentage water cut and water -oil ratio are used to predict the performance. The fresh simulation performed for the condition available in open literature, called base case, is in good agreement with the earlier published results. Nine different alternative arrangements were simulated and the best combination is reported where the

highest amount of cumulative oil production and highest percentage of enhancement of oil production can be achieved.

014

Development of Power Supply to Isolated Territories of Russia Based on Renewable Energy Sources

Konstantin Suslov*

Irkutsk National Research Technical University, 83, Lermontov str., 664074, Irkutsk, Russia

*souslov@istu.edu

The power system of Russian Federation is diversified regionally and consists of one Unified Power System and multiple off-grid power systems. Many parts of Russia are not connected to centralized power supply by virtue of their geographical position. There are more than five thousand autonomous energy sources in the off-grid territories, which are mainly represented by diesel power plants and gas turbines. These power plants use very expensive fossil fuel. A large number of distributed consumers which can be supplied with power electricity only from the autonomous energy sources and problems in the existing decentralized electricity supply system require that the issues of development and optimization of power supply be urgently solved. It is proposed to use for such systems a large share of generation based on renewable energy sources (RES). Taking into account a nonstationary character of power generation, presence of electricity storage devices, as well as stricter requirements of consumers to power quality and reliability of power supply, we can say that operating conditions of such systems and their control represent a difficult problem that needs to be studied. The tasks of substantiating the development of isolated power supply systems are considered. The analysis of the essence and level of study of groups of tasks to substantiate the development of such systems in a hierarchical sequence is given. The problem of substantiating development is presented in the form of three successive stages: substantiating a rational configuration of the power supply system, comprehensive optimization of the structure and parameters of the power supply system taking into account various requirements and studying the operating conditions. In the paper the specific features of microgrid operation in different seasons of a year and different time of a day are analyzed, a set of problems related to control of operation are formulated and specific features of their solving are discussed.

015

Exergy based comparison of two Gas Turbine Plants with Naphtha and Naphtha-RFG mixture as fuels

Sankalp Arpit^{1*}, Sagar Saren², Prasanta Kumar Das², Sukanta Kumar Dash²

¹School of Energy Science & Engineering, IIT Kharagpur, 721302, India

²Department of Mechanical Engineering, IIT Kharagpur, 721302, India

*sankalp.arpit815@gmail.com

The aim of this study is to develop detailed thermodynamic analysis of naphtha based GT power plant. For this purpose, a comprehensive energy analysis followed by exergy analysis of GT1 (Naphtha) and GT2 (Naphtha & Residual fuel gas) is presented. The parameters such as exergy exergy efficiency, physical exergy, chemical exergy and exergy destruction are evaluated considering real values of power plant control unit. Analysis pointed that exergy destruction in case

of GT2 is higher as compared to GT1 because of introduction of Residual fuel gas at 92°C. Also energy and exergy efficiency of GT2 is higher as compared to GT1.

016

**Decentralized solid waste management for educational-cum-residential campus:
A pilot study**

Deepak Singh Baghel^{1*} and Yogesh Bafna²

^{1,2} MPSTME, NMIMS, Shirpur, India

*deepak.baghel@nmims.edu

Growth of population and urbanization has given boost to Municipal solid waste generation in India. The municipal corporations throughout the country are facing problems to improve collection efficiency of waste and subsequently, treat and dispose the tonnes of waste generated daily. The decentralization of solid waste management could prove effective in managing such problems. The waste generated in India have more than 40 % of biodegradable organic matter. The existing methods of composting and biomethanation with numerous modifications by researchers have proved effective in treatment of such wastes and produce quality products viz, compost and biomethane which can be used further to improve soil quality and replace fuel respectively. This paper is a case study of these methods at a decentralized level to investigate their feasibility and present their applicability. The results show that composting using windrows is suitable in terms area requirement and nuisance created and produces 0.179 kg of manure/ kg of food waste of quality as recommended by various researchers and Fertilizer control order. A pilot plant for biomethanation is also designed and operated based on recommendations by researchers to produces biogas (treated methane) of 0.162m³/kg of TS.

017

Does the criteria of instability thresholds during Density Wave Oscillations need to be redefined?

Subhanker Paul*, Suparna Paul, Maria Fernandino, and Carlos Alberto Dorao

Department of Energy and Process Engineering

Norwegian University of Science and Technology, NTNU, Trondheim, Norway

*paul.subhanker@ntnu.no

Two-phase flow instabilities and in-particular Density Wave Oscillations (DWOs) are unwanted in boiling, condensation, and other flow boiling systems as it can cause severe deterioration in the performance or even damage the system. For decades, efforts have been focused on designing equipment or processes that operate far from the conditions where the two-phase flow instabilities are present. And hence multiple studies in particular experiments were carried out to identify the characteristics of the instability thresholds during the DWOs. In this work we show that the conventional approach of identifying the instability thresholds does not hold good to determine the global stability behavior of the system. This includes identifications of the limit cycle oscillations and the Hopf bifurcation across the instability thresholds. And hence, this study postulates the need for redefining the criteria and the approach to identify the instability thresholds experimentally.

018

Solar Energy for Meeting Service Hot Water Demand in Hotels: Potential and Economic Feasibility in India**Niranjan Rao Deevela^{1*} and Tara C Kandpal¹**¹Center for Energy Studies, Indian Institute of Technology Delhi, New Delhi (India)

*niranjandeevela@gmail.com

This paper presents an assessment of utilization potential and financial feasibility appraisal for meeting service hot water demand in star category hotels in India with solar energy. Service hot water demand and the means of hot water generation in such hotels were reviewed with the levelized (unit) cost of useful thermal energy estimated for the same. Using the software RETScreen4®, the required solar collection area as well as solar fraction for different locations in the country for both Flat Plate Collector (FPC) and Evacuated Tubular Collector (ETC) based solar systems were estimated. The collector areas varying in the range of 258 to 407 m² with average 0.55 solar fraction for FPC and 237 m² to 373 m² with average 0.65 solar fraction for ETC for 27 locations. Total roof area of few selected hotel buildings is estimated using satellite image system with the help of Google Earth™ version 7.3.2. The levelized (unit) cost of useful thermal energy delivered by solar water heating systems (SWHS) based on FPC and ETC is found to be vary between 0.85 to 1.05 Rs./MJ and 0.68 to 0.80 Rs./MJ respectively. Other measures of financial viability such as discounted payback period, net present value and internal rate of return for an incremental investment in solar water heating systems for generation of service hot water in star category hotels in India have also been estimated. The estimates of Payback period and NPV point towards financial viability of the same.

019

Techno-economic feasibility of condenser cooling options for solar thermal power plants in India**Tarun Kumar Aseri^{1*}, Chandan Sharma² and Tara C. Kandpal¹**¹ Centre for Energy Studies, Indian Institute of Technology, Delhi, India² Govt. Engineering College, Ajmer, Rajasthan, India

*tarunaseri@gmail.com

An analysis to study the effect of three condenser cooling options on techno-economics of parabolic trough collector based solar thermal power plants in India has been presented. Wet, dry and hybrid condenser cooling technologies are considered for a 50MW nominal capacity plant. The annual electricity output as well as the levelized cost of electricity delivered have been estimated. It is observed from the results obtained that the plants with the dry cooling technology are expected to generate approximately 5% less annual electricity. The cost of electricity delivery was observed to be 16% higher for a dry-cooled plant as compared to a wet-cooled plant. Similar analysis has also been undertaken for a hybrid cooled and results are presented.

020

Optical modelling of parabolic trough solar collector**Anish Malan and K. Ravi Kumar***

Indian Institute of Technology Delhi, New Delhi, 110016, India

*krk@ces.iitd.ac.in

In this article, the flux distribution of parabolic trough solar collector (PTSC) is performed by considering limb darkening effect in the incoming solar radiation. Inhouse model is developed using the MATLAB tool for the analysis. The effort is also made to reduce the computation time of CPU by converting the complete PTSC problem into two-dimensional model. The proposed model is used to provide the comparison of the flux distribution for sun considered as a uniform source and by considering the limb darkening effect in the sun source. The results have also been provided for the effect of change of aperture for same geometrical concentration ratio, rim angle and errors due to manufacturing incapacibilities on the flux distribution. It is desirable to upgrade the manufacturing standards for the manufacturing of the large aperture PTSC to improve the geometrical concentration ratio of the collector.

021

Cooling energy saving potential of naturally ventilated interior design in low-income tenement unit**Ahana Sarkar^{1*} and Ronita Bardhan¹**¹Centre for Urban Science and Engineering, Indian Institute of Technology Bombay, Powai 700046

*ahana.sarkar@iitb.ac.in

This article aims to exhibit the potential of natural ventilation (nat-vent) as a passive cooling method within the low-income tenement units in tropical climatic regions using Mumbai as a case example. Furthermore, it also highlights the significance of interior design and optimized location of 'active zone' in delivering improved experiential nat-vent levels. A mixed-mode approach involving iterated design scenario generation based on housing survey, computational fluid dynamics (CFD) simulations for natural and mechanical ventilation modes (air-conditioning and ceiling fan) along with energy consumption modelling was implemented here to investigate the cooling energy reducing potential of the nat-vent efficient indoor design. Results indicate that the selected interior design 'scenario 1' was capable of annual saving 364.43kWh of cooling energy with a cost reduction of INR 2575.86. This study by formulating a method to assess the environmental-economic impact of nat-vent efficient interior design would aid the building engineers in paving a way towards the formation of sustainable design guidelines.

022	Resilience of PV glass coatings to cleaning processes
------------	--

Klemens Ilse^{1,2*}, Paul-Tiberiu Miclea^{1,2}, Charlotte Pfau^{1,2}, Volker Naumann^{1,2}, Muhammad Zahid Khan^{1,2,3}, Ralph Gottschalg^{1,2} and Christian Hagendorf^{1,2}

¹Fraunhofer Center for Silicon-Photovoltaics CSP, Otto-Eissfeldt-Strr 12, 06120 Halle , Germany

²Fraunhofer Institute for Microstructure of Materials and Systems IMWS, Walter-Hülse-Str. 1, 06120 Halle, Germany

³Anhalt University of Applied Sciences, Faculty EMW, Koethen (Anhalt), Germany

*klemens.ilse@csp.fraunhofer.de

Regular cleaning of PV modules can damage glass surfaces and glass coatings. It becomes especially relevant in desert areas with high cleaning frequency due to increased soiling of the glass surfaces. Within this study, the damage potential of cleaning on solar glass (f | solarfloat T) and two different anti-reflective (AR) glass coatings (f | solarfloat HT and a commercial reference ARC) is examined. For this, a new cleaning test method was developed based on the estimated damage mechanisms for frequent dry cleaning processes in desert environments. It is based on existing cleaning/abrasion standards. The glass and coating abrasion is compared for the different samples with regard to changes in optical transmission and reflection behaviour as well as microstructural damage patterns. It is found that dry brushing causes only little damage to the uncoated glass surface and does not change hemispherical reflectance or transmittance even at high numbers of brush cycles. In contrast, both tested anti-reflective glass coatings indicate a significant reduction of AR performance already after 100 brush cycles. However, the f | solarfloat HT, that shows weaker AR performance in the initial state, exhibits a better stability during extended abrasion testing. This will be relevant for the choice of the best coating for realistic application scenarios.

023	The Human Dimension of Household Electricity Consumption: A Structural Equation Modelling Approach
------------	---

Jeetika Malik^{1*}, Ronita Bardhan¹ and Pradipta Banerji²

¹Centre for Urban Science and Engineering, Indian Institute of Technology Bombay, Mumbai, India

²Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, India

*jeetika.malik@iitb.ac.in

This study aimed at investigating the potential human factors influencing household electricity consumption. The specific focus was on the occupant behaviour, practices, habits and attitude towards energy in low-income housing. Household data was collected through a transverse survey conducted in slum rehabilitation colonies of Mumbai, India. A structural equation modelling approach was employed to assess the determinants of household electricity consumption in subject household. Three latent factors– “Adaptive Behaviour”, “Appliance-related behaviour” and “Attitude and Experience” were identified which collectively determined the electricity consumption. The results from the causal model provided interesting insights such as occupants who were energy conscious or those engaged in adaptive comfort measures tend to consume less electricity. This work established the role of human factors in energy consumption within the low-

income household and the findings could help in improving the building energy use through community and policy interventions.

026

Review of Latent Heat Thermal Energy Storage (LHTES) for low grade heat recovery applications and thermal performance enhancement techniques

Abhishek Agrawal¹ and Dibakar Rakshit²

¹The Energy and Resources Institute, New Delhi-110044, India

²Indian Institute of Technology Delhi, India

This paper presents the comprehensive review of Latent Heat Thermal Energy Storage (LHTES) using Phase Change Materials (PCMs) for low grade heat re-recovery applications in the temperature range less than 250°C [1, 2]. The review focusses on study of different PCMs suitable for solar air and water heating, so-lar stills, solar absorption cooling, waste heat recovery and solar thermal electricity generation. Furthermore, thermal conductivity enhancement techniques of PCMs, suitable heat exchangers, effect of various heat exchange parameters on thermal performance of PCM are also reviewed and discussed

028

Optimization of Intensification Process for the Synthesis of Biodiesel

Saeikh Z. Hassan* and Alaaddin M. M. Saeed

Department of Petroleum Studies Z. H. College of Engineering and Technology Aligarh Muslim University, Aligarh – 202002

*saeikhzhassan@gmail.com

Biodiesel (mixture of fatty acid alkyl esters) is an alternative diesel fuel produced mainly from lipids and fatty acids. Use of the low-cost feed stocks such as unrefined non-edible oils, waste cooking oils, and PFAD (palm oil fatty acid distillates) is necessary to produce biodiesel in a more economical way. Much of the process complexity originates from contaminants, such as water and free fatty acids (FFAs), in these feed stocks. Saponification occurs during alkali catalyzed transesterification of lipids when raw materials contain high amount of FFAs. Esterification of FFA to reduce FFAs content below 1 wt% is usually required. Acid catalyzed esterification is a reversible second order reaction and thus, as the reaction proceeds, reverse hydrolysis causes decrease in the production of fatty acid alkyl esters. The main objective of this study was to develop and optimize a low temperature intensification process to enhance the biodiesel yield and reduce the energy consumption. Three intensification methods studied were co-solvents technique, co-solvent method coupled with adsorption of water using molecular sieves, and entrainer based continuous removal of water. Co-solvent without adsorption method was effective in FFA conversion in the initial periods of reaction but in the later period, conversion reached to same value as obtained in the conventional method due to the poisoning effect of water. Co-solvent method coupled with adsorption step and entrainer based continuous water removal processes were found to be more effective in intensifying esterification of FFA. In the co-solvent coupled with adsorption process using 3 Å molecular sieves, conversion almost reached to 94% after 2 h at 9 molar ratio (methanol to FFA) and 58 °C. Finally, the techniques of design of experiments were used to optimize the process in terms of co-solvent/entrainer amount, molar ratio, temperature, time and catalyst amount.

030

Development of an Improved Cookstove: An Experimental Study**Himanshu, S. K. Tyagi* and Sanjeev Jain**

Indian Institute of Technology Delhi, New Delhi, 110016, India

*tyagisk@ces.iitd.ac.in

The thermal performance and emission characteristics of an improved cookstove utilizing biomass pellets as fuel has been investigated. The present work is focused on the development of an improved forced draft cookstove model having higher thermal efficiency and reduced emissions of particulate matter (PM 2.5) and carbon monoxide (CO). The improved cookstove consisted of two concentric cylinders with provision of both primary as well as secondary air. An air gap was provided around the combustion chamber to preheat the secondary air before being supplied for combustion, thereby reducing the heat losses. The flow rates of primary and secondary air were controlled to supply the optimum quantity of air, resulting in the complete combustion of volatiles and particulates before being released into the environment. The average value of thermal efficiency for the developed cookstove model was obtained to be around 36.82%, while the emissions of CO and PM 2.5 were respectively reported to be of 1.02 g/MJD and 29.96 mg/MJD following the standard test procedures mentioned in the Bureau of Indian Standards.

031

Techno-Economic Optimization Of Isolated Hybrid Energy System**Avinash Khatri KC^{1*}, Ashish Shrestha², Tika Ram Regmi¹ and Ramesh Kumar Maskey²**¹Nepal Engineering College, Changunarayan, Bhaktapur, Nepal²Kathmandu University, Dhulikhel, Kavre, Nepal

*avinashk@nec.edu.np

Implementation of renewable energy technologies is one of the promising and environment-friendly solutions to provide energy access to the rural area, where electricity supply through the extension of the national grid is impossible. However, the unpredictable nature of the renewable energy resources is one of the major drawbacks in development of such system resulting in high initial cost, less reliability and poor overall performance of the energy supplying technology, which can be improved by using sufficient storage devices or by interconnecting multiple energy resources type with optimal hybridization. In this study, a genetic algorithm based model for techno-economic optimization of an isolated hybrid energy system is proposed. For the data analysis and validation, solar PV, wind turbine, diesel generator as energy generating sources and batteries as storage device are considered, and the obtained results are compared with the result from standard software called HOMER. Different parameters such as sizing, number, and price of different components, temperature, autonomy days, and environmental factors are considered as the input variables to the model, and the price of electricity, loss of power supply probability and renewable fraction are obtained in the form of model output.

032	Impact of Demand Response Implementation in India with Focus on Analysis of Consumer Baseline Load
------------	---

Jayesh Priolkar^{1*} and Sreeraj ES²

¹NIT Goa, Goa, 403401, India

²NIT Goa, Goa, 403401, India

*jp@gec.ac.in

The stochastic nature of renewable energy sources creates unpredictable variability making instantaneous demand and supply a big challenge. Demand response (DR) which is an intentional modification of consumer loads as per utility requirement can support the intermittent nature of renewable energy sources, helping grid operators to quickly respond to power variability. Smart grids provide an opportunity for consumers to produce energy and feed it into the grid as well as control their energy requirement which is one of the important aspects of DR implementation. This paper provides an overview of various aspects of DR programs available in the literature from point of view of challenges, benefits, and applications. Various opportunities and challenges for DR deployment on renewable energy integration and smart grids from the Indian context are discussed in the work. The objective of the paper is to suggest drivers that will motivate DR deployment with effective renewable energy integration in the country. One of the important aspects of DR implementation in the country is to assess DR potential available among the different categories of consumers. Consumer baseline gives reference consumption which is used to assess DR potential. A case study has been conducted on one of the industrial feeder in Goa state to estimate consumer baseline load (CBL) using different methods. Average, maximum value, adjustment, and regression-based CBL estimation methods used for analysis are compared based on evaluated performance metrics. From the analysis, it is found that the adjustment method is most accurate for CBL estimation.

034	Double Dielectric Barrier Discharge-Assisted Conversion of Biogas to Synthesis Gas
------------	---

Bharathi Raja R^{1*}, R. Sarathi² and R. Vinu¹

¹Department of Chemical Engineering, Indian Institute of Technology Madras, Chennai, India

²Department of Electrical Engineering, Indian Institute of Technology Madras, Chennai, India

*bharathi.raja14@gmail.com

In the recent decade, the use of plasma technology for dry reforming of methane has gained significant interest. Owing to the adverse effects caused by the greenhouse gases like CO₂ and CH₄ on climate, the valorization of these pollutants is imperative, and this is also a challenging task. The current study focuses on developing a Double Dielectric Barrier Discharge (DDBD) reactor for the conversion of CO₂-CH₄ mixture to synthesis gas (H₂+CO). The non-thermal plasma was generated using two coplanar quartz electrodes with the outer one wrapped with copper tape that was grounded, and the inner stainless-steel rod connected to a high voltage source. The discharge gap of 2 mm and discharge length of 70 mm were maintained. The effects of specific energy input (SEI) and CO₂:CH₄ composition on the conversion rate of CO₂ and H₂/CO ratio were studied. The power dissipated in the reactor was calculated from the Lissajous plot by measuring the instantaneous charge deposited inside the discharge volume. The effective conversion of CO₂ increased with increasing SEI, and it

was maximum for CH₄:CO₂ of 50:50 (vol.%/vol.%). These are attributed to higher residence time of CO₂, which favors the production of CO and O by electron induced dissociation and electron dissociative recombination reactions.

035

An Integrated MCDM Approach for Selection of Sustainable Energy Source in India

S. K. Saraswat^{1*}, Abhijeet Digalwar², and S. S. Yadav³

^{1,2,3}Department of Mechanical Engineering Birla Institute of Technology & Science, Pilani. 333031 Pilani, India

*santosh.saraswat738@gmail.com

Energy is an inevitable choice for the sustainable development of the country, so the countries should properly plan to select the most sustainable alter-native energy sources. Identification of the most sustainable alternative energy source is a complex multi-criteria decision-making (MCDM) problem. The purpose of this study, to identify the most sustainable alternative energy source in India using an integrated fuzzy Analytic Hierarchy Process (AHP) and fuzzy Weighted Aggregated Sum Product Assessment (WASPAS) MCDM approach. This study performed the analysis covering six criteria of technical, economic, environmental, social, political, flexible and their related twenty-six sub-criteria. Experts were adopted the linguistic nomenclature to avoid any kind of incomplete or vague information. Fuzzy AHP was assessed to make a pairwise comparison and to obtain the weights of the considered criteria and sub-criteria. Fuzzy WASPAS (WSM + WPM) proposed for the ranking of the energy alternatives. Results show that economic criterion has the highest weights, followed by the environmental and technical criterion. Solar energy obtained as the most sustainable alternative energy source in India. Wind energy was chosen as the second-most sustainable alternative energy source order followed by the hydro and biomass energy. Sensitivity analysis was performed for the nine different cases of three MCDM approaches. Results were compared and validated with three other well-known MCDM approaches of VIKOR, TOPSIS, and PROMETHEE - II.

037

Thermo-Hydrodynamic Modeling of Direct Steam Generation in Parabolic Trough Solar Collector

Ram Kumar Pal and K. Ravi Kumar*

Centre for Energy Studies, Indian Institute of Technology Delhi, New Delhi 110016, India

*krk@ces.iitd.ac.in

Direct steam generation (DSG) in the parabolic trough solar collector (PTSC) has potential to improve the thermal efficiency and minimize the investment cost for solar thermal power generation. In the present work, three dimensional (3-D) numerical simulations of DSG in the absorber tube have been performed using computational fluid dynamics (CFD) approach to predict the fluid flow and heat transfer phenomena for uniform wall heat flux condition. Wall boiling model under Eulerian multi-phase flow has been used in this study and it includes modeling of turbulence, mass transfer and wall heat flux partition. The numerical modeling of DSG has been done in CFD software ANSYS Fluent 19.0 and the results have shown good agreement with the available experimental results. Two phase flow boiling pressure drop, volume fraction of vapor, liquid temperature and variation of fluid velocity in axial direction have been studied for different operating pressures and inlet mass flow

rates. It is observed that pressure drop is more at lower operating pressure for same mass flow rate and wall heat flux. Contours of volume fraction of vapor at different positions along the length of absorber tube have been predicted. It is found that vapor phase moves upward due to gravity and upper section of the tube gets dried.

039

Fouling Mitigation in Shell and Tube Heat Exchanger through CFD Simulation

Pramod Jadhav^{1*}, Kishor Nikam², Aniruddha Joshi³

^{1,2,3}Tata Consultancy Services, Pune 411006, India

*pramod.jadhav@tcs.com

Shell and tube heat exchanger (STHE) is a major heat transfer equipment which is widely used in oil refineries, chemical industries, food industries and many more. Fouling is one of the key factor affecting heat exchanger performance apart from corrosion, erosion or mechanical failure. Prediction of fouling plays an important role in design and operating stages of a heat exchanger. Thermal resistance due to fouling in any heat exchanger is computed either by experimental, analytical, computational fluid dynamics (CFD) or artificial neural network (ANN) methods. The CFD method used in the present work promises cost effective method to predict fouling potential zones and its mitigation strategy during design stage. Various CFD techniques are reviewed to model fouling phenomenon based on complexity. The CFD post processing with semi-empirical equation technique is used to plot fouling resistance contours in the STHE. With careful observation of CFD results, baffle design is found out to be the most important STHE's parameter affecting shell side fouling. The present work compares shell side fouling with 5 different baffle arrangements. Intermediate deflecting baffle arrangement mitigates shell side fouling to a considerable extent compared to conventional STHE design with no increase in pressure drop.

043

Hydrodeoxygenation of Bio-oil from Fast Pyrolysis of Pinewood over Various Catalysts

Kavimonica Venkatesan^{1,2*}, Parasuraman Selvam^{2,3,4}[0000-0001-7807-2985], and Ravikrishnan Vinu^{1,2}

¹Department of Chemical Engineering, Indian Institute of Technology-Madras, Chennai 600036, India

²National Centre for Catalysis Research, Indian Institute of Technology-Madras, Chennai 600036, India

³Department of Chemistry, Indian Institute of Technology-Madras, Chennai 600036, India

⁴School of Chemical Engineering and Analytical Science, The University of Manchester, Manchester M13 9PL, United Kingdom

*kavimonica02@gmail.com

Fast pyrolysis is the most promising technique for the production of biomass-derived fuels, which is a substitute for petroleum-based fuel oil. Catalytic upgrading of pyrolysis vapours from biomass improves the quality of biooil to a greater extent by deoxygenation so that the upgraded bio-oil can be used as a hydrocarbon fuel. This work is mainly focused on studying the effect of various catalysts

such as hierarchical HZSM-5 zeolites of different Si/Al ratios, commercial HZSM-5, and W2C/ γ -Al₂O₃, on hydrodeoxygenation of organic

compounds from pinewood pyrolysis. Catalytic hydrodeoxygenation experiments were conducted in an analytical pyrolyzer with ex-situ catalytic upgrading zone, which was connected to a gas chromatograph/mass spectrometer. Hierarchical zeolites exhibited significant deoxygenation activity producing aromatic hydrocarbons. The degree of deoxygenation had a good correlation with the acidity of the zeolites. Hierarchical HZSM-5 (20) produced aromatic hydrocarbons at ~88% selectivity. Furthermore, unconventional W2C/ γ -Al₂O₃ serves as a potential hydrodeoxygenation catalyst, producing 97% selectivity to hydrocarbons. In addition, W2C/ γ -Al₂O₃ overcomes the drawback of coke formation on acidic sites of zeolites.

046

Nanosensors: An improved tool for downhole hydrocarbon detection

Shilpa Nandwani¹, Mousumi Chakraborty¹ and Smita Gupta¹

¹Department of Chemical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, India

Nanosensors have recently attracted the oil and gas industries for acquiring a panoramic insight of the oil reservoirs. Such nanodevices are found to be advantageous as compared to the conventional mechanical, electrical and optical sensors used in reservoir characterization and oil exploration. The indispensable need for developing sensing devices that work efficiently under high-pressure/high-temperature conditions of the reservoir has paved way for nanosensors. This new class of nanomaterials has overpowered the conventional sensing techniques. Conventional sensing techniques are incapable of acquiring data at a large distance from the injection point. Recent developments have shown that carbon and silicon based nanosensors can be used in reservoir characterization and hydrocarbon detection. Moreover, nanosensors in combination with certain conventional monitoring systems are anticipated to substantially improve the imaging outcomes thereby assisting the oil and gas industries in tuning the oil recovery methods for profitable outputs. Nanosensors provide accurate 3D reservoir characterization and even slight improvement in the sensing capability of hydrocarbon detection and in-situ chemical composition will produce exponential benefits. This paper provides an overview of how nanosensors prove to be more efficient than the conventional sensing systems used for reservoir characterization and hydrocarbon detection by the oil and gas industries till now.

049

Simulation of Horizontal Axis Wind Turbine using NREL FAST Solver

Asmelash Haftu Amaha, Prabhu Ramachandran, and Shivasubramanian Gopalakrishnan
Indian Institute of Technology Bombay, Powai, Mumbai 400076

The work presented here demonstrates the simulation of flow through a Horizontal Axis Wind Turbine (HAWT) using the NREL FAST solver. Computation of flow past the NREL phase VI experimental horizontal axis wind turbine is performed. The computations are made on the basic model with 0° yaw angle and 3° pitch angle at the tip. The turbine rotates at 7.54 rad/s for wind speed ranging from 5 m/s - 25 m/s. This turbine has been extensively used for testing purposes. We compute

the flow through the HAWT blades using the solver and compared the solution with both the experimental and computation fluid dynamics (CFD) results available in the literature. We are able to obtain the results with very good accuracy, and compared to CFD, the solution was achieved with significantly less computational effort.

050

Energy saving potential through design and planning in slum rehabilitation housing in Mumbai

Bangkim Kshetrimayum*, Ronita Bardhan

Centre for Urban Science and Engineering (CUSE), Indian Institute of Technology Bombay, India.

The study aims to investigate the energy saving potential through design and planning in slum rehabilitation housing in Mumbai which aims at improving the quality of lives of nearly 6 million people living in informal settlements. Proper design and planning of buildings can optimize the energy consumption during building construction and operation. However, limited study exists on the design and planning of rehabilitation housing in India. A field survey was done in one slum rehabilitation housing in Mumbai to explore the built environment. Further, data on satisfaction with the residential environment and socio demographic variables were collected with the help of trained interviewers from 323 households in the public housing during October and December 2018. The findings indicate that people are dissatisfied with non availability of multipurpose space, parking space. After analysis of the built environment and people's satisfaction level it was found that the energy consumption during construction phase and the operation phase could have been much reduced through proper design and planning. The findings indicate that 12 courtyards of size 19.15mx19.15m each could have been easily incorporated in the design thus providing multipurpose space and parking facilities within the same space. Further, the number of lift and staircase could be reduced from 24 to 14 and 36 to 20 respectively without affecting the efficiency thus reducing energy cost. Air circulation, daylighting, dry area facilities could be enhanced in the new design. Findings reveals that public participation in the design and planning phase are necessary for future rehabilitation housing.

051

Do energy policies with disclosure requirement improve firms' energy management? Evidence from Indian metal sector

Mousami Prasad¹

¹*Research Scientist, IIT Bombay, India

*mousamiprasad@gmail.com

Climate change poses serious threats to mankind and biodiversity and the concerns have resulted in efforts from all nations. India alone is responsible for 6% of global CO₂ emissions with a significant contribution from energy-intensive industries. Energy policies with different compliance requirements have been introduced to lower firms' emissions. Some policies require specific quantitative information to be disclosed, while others have more general requirements. However, the empirical evidence of the impact of different energy policies on emissions remains limited. This study, therefore, examines what role disclosure-based energy policies have on the decarbonization of firms. For this, the study builds and examines the emission profile of firms from the energy-intensive sector: metal sector. Further, using the economics of emission framework, it is argued that energy

policy with disclosure requirements can reduce emissions. The study has implications for public policy and corporate managers.

054

Sensitivity analysis of Parabolic Trough Concentrator in SolTrace

Anupam Sharma¹

¹*School of Electrical Sciences, IIT Goa, 403401-Goa, India

*anupamsharma.gec@gmail.com

At solar noon, sensitivity analysis of Parabolic Trough Collector (PTC) has been done using Ray tracing software “SolTrace” by NREL. The effect of rim angle, reflectivity of concentrator, aperture width & length, transmissivity of glass cover, refractive index of glass tube & thickness of glass cover have been analyzed with and without optical errors. Various techniques have been obtained to maximize the flux on receiver. Simulation has been done in SolTrace and presented graphically.

055

Power Management of Non-Conventional Energy Resources Based DC Microgrid Supported by Hybrid Energy Storage

Jayendra Kumar^{1*}, Anshul Agarwal^{2#} and Nitin Singh^{3\$}

¹MNNIT Allahabad, Prayagraj 2110004, India;

²NIT Delhi, Delhi 110040, India;

³MNNIT Allahabad, Prayagraj 2110004, India;

ree1607@gmail.com

#anshul@nitdelhi.ac.in**

\$nitins@mnnit.ac.in***

DC Microgrid is advantageous over AC Microgrid in terms of compatibility with the non-conventional power sources like solar, Energy conversion devices like fuel cell, storage devices like battery and supercapacitor and modern DC load. Power management in an isolated electrical system has been always a great concern to guaranty maximum utilization of intermittent sources and supply the reliable power to load. This paper presents a power management scheme for the proposed DCMG. The proposed DCMG includes an intermittent renewable source (Solar PV), an energy conversion device (Fuel Cell), a hybrid energy storage system (Battery and supercapacitor) and a variable DC load. Solar PV connected to the DC bus through unidirectional DC/DC converter and storage devices and fuel cell connect with the DC bus through bidirectional DC/DC converter. The output power of the solar PV is controlled by hill climbing incremental conductance (INC) algorithm to operate at MPPT. A MATLAB/Simulink demonstration of the proposed system is simulated and the obtained results are discussed.

058	Sizing of a solar powered adsorption cooling system for comfort cooling
------------	--

Sai Yagnamurthy¹, Dibakar Rakshit^{*1} and Sanjeev Jain²

¹Centre for Energy Studies, Indian Institute of Technology Delhi, Delhi-110016, India

²Department of Mechanical Engineering, Indian Institute of Technology Delhi, Delhi-110016, India

^{*}dibakar@iitd.ac.in

Solar powered adsorption cooling technologies have been demonstrated by various researchers worldwide to be feasible for small scale applications and part load conditions. Similar to the other solar thermal powered cooling technologies, the constraint of oversizing issues pertains in autonomous systems without backup. In the current study the performance assessment of a solar thermal adsorption cooling system has been carried out in TRNSYS for a polygeneration systems project aiming to address the comfort cooling needs of a staff room of a school building near Roorkee, India. A simplistic approach has been proposed for the estimation of collector aperture area and storage volumes, using the monthly averages of daily cooling energy, peak cooling loads and daily average solar irradiation. An economic analysis applied on the results obtained from the proposed approach yielded the optimal collector area and storage volumes of 40m² and 300L respectively to mitigate CO₂ emissions with minimal costs under the given load conditions. A detailed analysis conducted in TRNSYS with various collector aperture areas and storage volumes along with control strategies adapted to follow the IMAC thermal comfort recommendations, showed that there was little deviation (around 5%) between the solar cooling fractions estimated using the proposed approach and those computed from TRNSYS, for various collector areas. It was also observed that the costs incurred for CO₂ mitigation, varied by less than 1% using the optimal collector sizing estimated by the proposed approach from that of the costs incurred using the optimal sizing suggested by TRNSYS.

059	Experimental Evaluation of Common Rail Direct Injection Compression Ignition Engine with EGR using Biodiesel
------------	---

Suresh D Mane^{*1}, Chinna Bathulla²

¹Girijabai Sail Institute of Technology, Karwar, Karnataka, India 581345

²Dept. of Energy and Materials Engg., Dongguk University, Seoul 04620, Republic of Korea

^{*}mane.suresh@gmail.com

India is poised to introduce the new Bharat Stage VI emission norms on its IC engines with effect from April 2020. Hence study was undertaken to evaluate performance and emissions of a CRDI diesel engine using diesel ie B0 and B25 blend with water cooled EGR arrangement. Single cylinder four stroke direct injection engine was modified to common rail direct injection and EGR provision made with water cooling arrangement. The engine was run on petroleum diesel with and without EGR arrangement at 5 different loads from 0 to 100% of rated capacity. Similarly the biodiesel prepared from Honge oils was used in B25 blend to run the engine at no load, 25%, 50%, 75% and 100% of rated capacity. The smoke emissions from engine running on diesel with EGR are greatly reduced in engine from 25 HSU to 1 HSU at full load operation vis a vis Non EGR. Similarly B25 with EGR has shown 50% reduction in smoke when compared with without EGR from 3.4 to 1.7

HSU at full load operation. NO_x emissions increased after 50 % of loading to 1800 ppm and 2000 ppm at full loads for diesel and B25 respectively without EGR. With EGR one third reduction in NO_x was observed at 600 ppm with both the fuels. CO and HC emissions show an increasing trend with EGR operations due to want of oxygen for combustion. To meet the upcoming Bharat stage VI norms next year it is evident that EGR and 3 way catalytic converters with after treatment equipments like DPF will be essential to meet the stringent emission standards for diesel engines.

061	Emission Measurement Considerations for Power Industry
------------	---

A. Bekal, Karthick S. K., Y. Rajeshirke, G. Balasubramaniam, M. Upadhyay, S.Bhandarkar, D. Kuvalekar and C. Mitra

¹Forbes Marshall Pvt. Ltd., Pune, Maharashtra 411034, India

An increase in coal consumption for coal based power plants in recent years led to an increase in implementation of air quality control systems. The operation of air quality control systems are dictated by the availability of better emissions measurement system. Recent advances in optical technology enabled better in-situ and extractive method of monitoring the pollutant species from the flue gas. Sample handling is a very important aspect of measurement process as important as the measurement technique. In-situ is the best technique for measuring emitted species without interfering the flue gas composition. However, due to various challenges like, high temperature, dust and slurry particulate carryover and moisture interference, extractive approach with advanced filtration and sampling system is generally preferred. Advanced techniques using Quantum Cascade Lasers has recently opened up highly sensitive measurement at high temperatures (above 200oC). This paper gives a general view of emission measurement methods and also discusses both the monitoring methodologies available and state-of-art research in progress globally.

064	Impact of Growing Share of Renewable Energy Sources on Locational Marginal Prices
------------	--

Leena Heistrene^{1*}, Yash Shukla¹, Yaman Kalra¹, Poonam Mishra¹, Makarand Lokhande²

¹Pandit Deendayal Petroleum University, Gandhinagar – 382 007, India.

²Visvesvaraya National Institute of Technology, Nagpur – 440010, India.

*leena.santosh@sot.pdpu.ac.in

In this paper, the impact of renewable energy sources (RES) on the locational marginal prices (LMP) of a fully competitive pool-based electricity market is analysed. Renewable energy sources are usually given the highest priority in market clearing problem by assigning zero or negative energy offer prices. It is expected that inclusion of such sources with zero bidding price would bring down the marginal price especially as the penetration of such sources increases. In this paper changes in LMPs observed under different levels of wind penetrations into conventional grid have been analysed. It is observed that in congested networks, in some buses LMP increases with increase in wind penetration instead of decreasing. Secondly, a tipping point is observed in the nature of LMP at every bus. In the case study adopted for validation in this paper, the nature of LMP changes when wind penetration has gone beyond 20%. Analysing such changes in LMPs provide insight to the market participants such as conventional power plant owners, wind turbine owners and demand

response aggregators into the nature of LMP. This would, in turn, help them in optimally plan their bidding and offer strategies.

068	Performance Evaluation of Wind - Solar Hybrid System in Indian Context
------------	---

Rahul Shityalkar¹, Ranjan Dey², Anagha Pathak³, Niranjan Kurhe⁴, Sandesh Jadkar⁵

¹Department of Mechanical Engineering, Birla Institute of Technology and Science Pilani, K K Birla Goa Campus, Goa 403726, India.

²School of Energy Studies, Savitribai Phule Pune university, Ganeshkhind, Pune 411007, India. drpathakam@gmail.com

Renewable energy is an abundant and clean source of energy, which is also economical now a days. To utilize these energies, current technologies are still not developed enough and we still have to greatly depend on non-renewable energies for meeting the base load demand. Development of new methods for renewable energy generation, storage and distribution and improvements in the existing technologies is essential to meet the increasing energy demand. Keeping this in mind, the present investigation was carried out on the wind – solar hybrid system of 15 kW capacity out of which 5.4 kW is solar energy based and 9.6 kW is wind energy based. The system was monitored and data was analyzed throughout the year for performance evaluation of the system. The energy generation data was used to compare the actual performance of the hybrid system against the expected performance with respect to the demand. It was observed that the performance of the solar PV system was better than the expected output and the performance of the wind turbine was not as per the expectations in most of the months due to low wind speed. However, it was observed that the energy generation from the solar modules and wind turbine was complementary to each other. The poor performance of the solar modules during the rainy season was compensated by the maximum power generation by the wind turbine. The overall energy generation from the wind-solar hybrid system was stable throughout the year which was otherwise not possible from the independent solar or wind installations.

072	Structural, Electrical and Cell Performance Study on Lithium Germanium Phosphate Glass-Ceramics based Solid State Li-Electrolyte
------------	---

Anurup Das¹, Madhumita Goswami¹, Preetham P³, S. K. Deshpande², Sagar Mitra³, M. Krishnan¹

¹Glass & Advanced Material Division, Bhabha Atomic Research Centre, Mumbai-400085, In-dia

²UGC-DAE CSR, Mumbai-400085, IUDCT, India

³Electrochemical Energy Laboratory, Department of Energy Science and Engineering, Indian Institute of Technology-Bombay, Powai-400076,

Solid State Electrolytes (SSEs) can address the safety issues related to liquid electrolyte and chemical stability at high temperature. Among others, glass-ceramics, based on NASICON phase are well studied as ionic conductor because of their high room temperature ionic conductivity. In this work we report the synthesis of lithium germanium phosphate glass of composition Li_{1.5}Al_{0.5}Ge_{1.5}P_{2.9}Si_{0.1}O₁₂ (LAGPS) by conventional melt quenching technique and conversion into glass ceramics using optimized process parameters. X-ray Diffraction (XRD) measurement confirmed the formation of the desired phase (Li_{1.5}Al_{0.5}Ge_{1.5}P_{2.9}Si_{0.1}O₁₂). The ionic

conductivity was measured using Electro-chemical Impedance Spectroscopy (EIS) and the value was found to increase from $1.02 \times 10^{-6} \text{Scm}^{-1}$ to $2.03 \times 10^{-4} \text{Scm}^{-1}$ with increase in temperature from 223K to 303K. Low temperature EIS was done to see the individual contribution from grain and grain boundary. The activation energy of ionic conduction was calculated and the value was found out to be 0.45eV. Cells were fabricated with LiFePO₄ (LFP) as cathode and Li metal as anode. The cell operated successfully giving capacity of 130mAhg^{-1} with coulombic efficiency of 99% at 0.05C ($1\text{C}=170 \text{mAhg}^{-1}$) at initial stage of experiments.

073

Mathematical Model using Poissons distribution for power outage frequency prediction for power generating machine's load simulations.

Anwar Wali Gutti^{1*}

¹Sr. Loads engineer (wind turbines), Suzlon Energy ltd., Pune 411028, India

*anwargutti@gmail.com

Today one of the major challenge that the Wind energy generating industry face is the grid loss or the power outages which can be defined as the fault or loss of electrical network connection that does not cause an immediate shutdown and the subsequent loading can lead to significant fatigue damage to the gearbox and other components of the energy generating machines. In the load calculations of gearbox, significant hours are considered in the load simulations as the grid loss hours. These grid loss events or the power outages depend upon the respective locations, city or country respectively. The data available from the government organizations, private power suppliers and the World Bank reports greatly varies in terms of years and the type of events that causes the outages. In this paper a mathematical model is prepared using the poissons distribution along with the frequency index data to predict the approximate no. of power outages for different continents. These no. of outages can be used by for carrying out load simulations of the gearbox with more accuracy.

074

Adaptive Relaying Scheme for a Distribution Network with Highly Penetrated Inverter Based Distributed Generations

Kirti Gupta^{1*} and Saumendra Sarangi^{2#}

¹National Institute of Technology, Uttarakhand

²Motilal Nehru National Institute of Technology, Allahabad

*kirti.gupta.eee17@nituk.ac.in

#usomsam@gmail.com

The integration of inverter based distributed generations (IBDGs) is gaining huge popularity in the modern distribution network owing to its clean generation in comparison to the conventional sources. Such deployment poses problem for protection system engineers to maintain reliable, dependable and coordinated operation of relays. The reason being the inverter control techniques to supply limited current in the network in order to protect its electronic components. The problem aggravates when its penetration increases. The staircase current waveform is obtained in such a network as magnitude of current increases with each disintegration of IBDGs, depending on the protection scheme for the IBDGs. Keeping this in mind, an adaptive method has been proposed by using Superconducting Fault Current Limiters (SFCLs) to limit extra current, subsequently no requirement

of further modifications in the setting of relays. The proposed method has been tested and verified on IEEE 12 bus distribution network.

075

Microalgae growth study with High CO₂ Concentration stream- Experience with native species

Indresh Tiwari¹ and Sydney Lobo²

Tata Power Company Limited Carnac, Mumbai-40009, India

¹indresh.tiwari@tatapower.com

²sydneylobo@tatapower.com

Tata Power has thermal power generation as one of the portfolios. As a responsible company, Tata Power is exploring ways to reduce its carbon di-oxide (CO₂) emission. The biological process is one such way. As the micro-algae is known for faster uptake of CO₂ than any other plants, the native microalgae species such as *Chlorella* sp, *Nannochloropsis* sp., *Dunaliella* sp and *Spirulina* sp. were tried to see the effects. Tata Power has done experiment with microalgae to find out species which can uptake maximum CO₂ concentration. This paper attempts to highlight the experiment details and results with *Chlorella* sp, *Nannochloropsis* sp., *Dunaliella* sp and *Spirulina* sp. The species were acclimatized with 10% CO₂ for inoculums. This inoculum was used for study with 20% & 40% CO₂ concentration. It was observed that *Chlorella* sp. could sustain and grow well with highest concentration of 20% & 40% CO₂-N₂ mixture in controlled Photo-Bioreactor (PBR) conditions. The steady growth was observed with these CO₂ concentrations. The growth cycle of *Nannochloropsis* sp. was fast, however CO₂ concentration endurance was low. The experiments were done mainly with *Chlorella* sp. and *Nannochloropsis* sp. The paper also discusses the challenges faced and mitigation measure adopted.

076

Optimization in the Operation of Cabinet Type Solar Dryer for Industrial Applications

Vishal D. Chaudhari^{1,2}, Govind N. Kulkarni³, C.M. Sewatkar^{1*}

¹Department of Mechanical Engineering, College of Engineering, Pune, S.P. Pune University, Pune, India

²Department of Mechanical Engineering, Cusrow Wadia Institute of Technology, Pune, India

³Department of Mechanical Engineering, Symbiosis Institute of Technology, Lavale, Symbiosis International (Deemed University), Pune India

*cms.mech@coep.ac.in

One of the major constraints in the acceptability of solar dryer in Industrial applications is the lack of control on the drying temperature. This paper, proposes a mathematical model of a cabinet type solar dryer that exhibits a control on the drying temperature using auxiliaries. The proposed model takes set temperature and solar radiation intensity as input and estimates auxiliary energies required to maintain the desired temperature. The analysis minimizes the energy consumption of auxiliaries while maintaining a constant dryer space temperature. Results with an illustrative example indicate that at a set temperature of 45°C, total auxiliary energy will be minimum at 97.3 kWh per day. Dryer will be more effective if operated in the day time. Then the optimum set temperature will be 50°C while auxiliary consumption will be reduced to 39.4 kWh per day. The proposed model assures to

be a simple tool in the resource estimation of batch type industrial dryers suitable for integration with solar heat.

077	Modeling of Solar Photovoltaic assisted Electrolyzer-Polymer Electrolyte Membrane Fuel Cell to Charge Nissan Leaf Battery of Lithium Ion Type of Electric Vehicle
------------	--

Dr. Kamaljyoti Talukdar^{1*}

¹Dept. of Mechanical Engineering, Bineswar Brahma Engineering College, Kokrajhar-783370, Assam, India

*kamaljyoti.talukdar@gmail.com

In this paper electric vehicle's battery of lithium ion type(Nissan Leaf) is being charged with the help of solar photovoltaic modules assisted by electrolyzer-polymer electrolyte membrane(PEM) fuel cell. The study is made for Nissan leaf battery capacity considered to be 40 kWh which can allow travelling of 400 km with a single 40 kWh battery at single full charge. The working voltage is 360 V. The study have been conducted for the month of May and December for the city of Kolkata because if the battery can be charged in maximum solar radiation (May) and minimum solar radiation (December), then the charging of the battery can be done throughout the year. The study reveals that 10 solar photovoltaic modules in parallel each having 11 modules in series of Central Electronics Limited Make PM 150 with a 15.661 kW electrolyzer and 1 PEM fuel cell stack of 21.24 kW, can support the current requirement of electric vehicle throughout the year when considering system voltage to be 360 V. 34 solar photo-voltaic modules in parallel each having 2 modules in series of Central Electronics Limited Make PM 150 is needed to run the gas compressor for storing hydrogen in the cylinder during sunshine hours when considering system voltage for compressor to be 48 V.

078	Mathematical Analysis of Convection Heat Loss from Solar Cavity Receiver Dish Concentrator
------------	---

R. Sinha¹ and Nitin. P Gulhane²

¹Department of Mechanical Engineering, VJTI, Mumbai, India.

*ramolasinha@somaiya.edu

The cavity receiver for solar parabolic dish system is used for low and medium temperature process heat, as well as for high temperature power generation. The convection heat loss from cavity receiver mainly determines the performance and the cost effectiveness of the dish receiver system. The convective losses from these solar cavity receivers are function of many variables like; cavity receiver inclination (θ), cavity wall conditions, aspect ratio (L/D), opening ratio (d/D), cavity wall temperature (T_w/T_a) and external wind condition. The analysis of convective losses from solar cavity receivers is most complicated as compared to heat transfer by radiation and conduction. The aim of this paper is to give mathematical analysis of convection heat loss at low as well as high temperature to predict accurate estimation of heat loss in different boundary conditions. The analysis is on the basis of experimental results in published data, using regression analysis. In mathematical analysis of the convection heat loss, the effect of cavity mean temperature and cavity inclination angle (θ) at low, as well as high temperature application is analyzed. In addition, this paper also develops convection Nusselt number correlation from experimental result of published data. The convection heat loss

Nusselt number correlation, developed for the temperature ratio (T_w/T_{amb}) varies between 2.0561 and 3.0462 and Grashof number in the range of 3.39×10^6 to 10.2×10^6 and match well with the experimental results within $\pm 15\%$.

079

Advance Research and development in electricity transmission and distribution

MK Bansal¹, and Dr Pratibha Garg²

¹AGM in NTPC Ltd, Noida (mkbansal@ntpc.co.in) and pursuing PhD in power distribution

²Associate Professor in Amity University, Noida (pgarg1@amity.edu)

Research & development activities in electric transmission and distribution technologies shall not only increase the reliability of the distribution network apart from improvement in quality management of electricity, which shall benefit the consumer at large. Research and development in smart grid, micro grid, energy storage,, research in Management of Alternative Power Resources, Energy Efficiency and Demand and supply Response are some of the areas in which R&D activities are increasingly making headway in improving the quality of distribution. The present article shall elaborate the some of the main features and advancement in energy sector.

080

Performance Study of a Anode Flow Field Design used in PEMFC Application

Yogesh S A¹, Prakash C Ghosh^{1*}, Raja Munusamy²

¹Department of Energy Science & Engineering, Indian Institute of Technology, Powai, Mumbai 400076, India

²Engineering Research centre, Tata motor limited , Pimpri, Pune 400014, India

*pcghosh@iitb.ac.in

Fuel cell systems offer an efficient and sustainable energy conversion solution for automobile and stationary backup application. Fuel cell stack consists of a bi-polar plate made of a conductive material usually graphite. Bipolar plate is a key component in the fuel cell stack, as it associates every cells electrically, supplies reactant gasses to both anode and cathode, and expels heat from the cell. In this paper will discuss on the performance study of a four different anode flow field configuration keeping cathode flow configuration same. The four different configuration flow designed namely serpentine flow with uniform curvature, Combined Pin and parallel flow, serpentine flow with 90-degree uniform curvature, Combination of Parallel and Serpentine flow channels. Carried out numerical and experimental analysis and compared the performance results with the voltage and current curve (Polarization curve). The assembly consists of single cells setup open cathode with in-house prepared membrane electrode assembly, testing has been carried out with consistent flow rate of air and hydrogen to investigate the anode stream channel impact on the performance. The outcomes were plotted in V-I polarization curve, From the results combination of serpentine flow with uniform curvature on the anode side flow channels offered higher performance at a current density of 350 mA.cm². Also carried out the temperature variation in the maximum performance flow field design and the outcomes were plotted in V-I polarization curve w.r.t to temperature.

082

Analysis of suitability of Concentrated Solar Thermal Technology to meet the heating needs of the Oil Industry

Pankaj Kumar

p.kumar@unido.org/vpankajk@gmail.com

Fuel cell systems offer an efficient and sustainable energy conversion solution for automobile and stationary backup application. Fuel cell stack consists of a bi-polar plate made of a conductive material usually graphite. Bipolar plate is a key component in the fuel cell stack, as it associates every cells electrically, supplies reactant gasses to both anode and cathode, and expels heat from the cell. In this paper will discuss on the performance study of a four different anode flow field configuration keeping cathode flow configuration same. The four different configuration flow designed namely serpentine flow with uniform curvature, Combined Pin and parallel flow, serpentine flow with 90-degree uniform curvature, Combination of Parallel and Serpentine flow channels. Carried out numerical and experimental analysis and compared the performance results with the voltage and current curve (Polarization curve). The assembly consists of single cells setup open cathode with in-house prepared membrane electrode assembly, testing has been carried out with consistent flow rate of air and hydrogen to investigate the anode stream channel impact on the performance. The outcomes were plotted in V-I polarization curve, From the results combination of serpentine flow with uniform curvature on the anode side flow channels offered higher performance at a current density of 350 mA.cm². Also carried out the temperature variation in the maximum performance flow field design and the outcomes were plotted in V-I polarization curve w.r.t to temperature.

083**Effect of Top Losses and Imperfect Regeneration on Power Output and Thermal Efficiency of a Solar Low Delta-T Stirling Engine****Siddharth Ramachandran¹, Naveen Kumar and Mallina Venkata Tim-maraju**

Indian Institute of Information Technology, Design and Manufacturing Kancheepuram, Chennai 600127, India

mdm16d001@iiitdm.ac.in

Stirling Engines are known for converting thermal energy to mechanical work with fair efficiency and no emission. A simple and relatively accurate model is necessary to predict the effective performance of energy systems utilizing solar thermal energy from preliminary design stage. Therefore, a finite time thermodynamic model of an irreversible low-temperature differential Stirling engine incorporating top loss due to heat transfer has been presented for the first time. The effect of parameters such as absorptivity of the glass cover, top loss coefficient and time for regeneration process on thermal efficiency and power output of the engine is investigated. The absorptivity of the glass cover did not significantly influence the top loss coefficient and thermal efficiency of the solar Stirling engine. The top loss coefficient reduced thermal efficiency of solar Stirling engine by 3%. Further, the power output of the engine increases about 3 W if the engine is operated at higher speed i.e., by reducing regenerative time duration by 0.005 sec. The present model could predict the temperature of working fluid within a deviation of ± 10 percent compared with experimental results.

084

Performance evaluation of photovoltaic winnower cum hybrid solar dryer for drying date palm (*Phoenix dac-tylifera L.*) fruit**Surendra Poonia^{1*}, A.K. Singh² and Dilip Jain³**

Division of Agricultural Engineering and Renewable Energy, ICAR-Central Arid Zone Research Institute, Jodhpur, India.

*poonia.surendra@gmail.com

Considering the requirement of a simple winnowing device in rural areas of Thar desert of Rajasthan for cleaning the grains and extending the utility of the system for dehydrating fruit and vegetables under forced convection mode of air, a PV hybrid solar dryer cum winnower was designed, developed and tested at Central Arid Zone Research Institute, Jodhpur, India. The system comprises a PV winnower, pre air-heating tunnel and inter connecting fixtures for using the winnower's fan to let the hot air enter into especially designed drying cabinet provided with glazing at the top, front and the east facing side and having twelve drying trays stacked one above another in two compartments. The drying experiment for dehydrating date palm (*Phoenix dactylifera L.*) was conducted in this hybrid solar dryer during month of June 2018. During the performance evaluation, the maximum stagnation temperature inside the drying chamber was observed 68°C and on loading with 8 kg date palm it reduced to 62°C, while outside ambient temperature was 32°C on a clear sky day (from 08:00 h to 18:00 h) in the month of June, 2018. The fruits were dried to safe moisture content (25%) in a period of 192 h. The temperature gradient, inside the drying chamber reduced from 6-8C to 2-3C in the improved system with pre-heater, which led to provide reasonably uniform drying. A mathematical model was also developed for predicting the temperature of pre air heating tunnel and drying chamber. As a winnower about 190-290 kg grains could be separated from threshed material in a day. The winnower was found suitable for winnowing when there was lull in the natural wind. The winnower was also used in the development of a dryer to enhance the utility of the system and year round applications.

085

Power Quality Enhancement in Distributed Generation by using Custom Power Device**Kishor Bhadane**

kishor4293@yahoo.co.in

Wind Energy (WE) becomes very popular for Distributed Generation (DG). This case presents the monitoring, modeling, control and analysis of two levels three phase WE based DG system where the electric grid interfacing Custom Power Device (CPD) is controlled to perform the smart exchanging of electric power as per the Indian grid code. WE is connected to dc link of CPD for grid integration purpose. The CPD i.e. DSTATCOM is utilized as compensator for injecting the wind power to the Point of Common Coupling (PCC) and also act as compensator against the reactive power demand. The novel indirect current control scheme of DSTATCOM regulates the power import and export between the WE and the electric grid system and also acts as compensator or performs both the key feature simultaneously. Hence the penetration of additional generated WE power to the grid is increased by 20to25 %. The Burdon of reactive power compensation from grid is reduced by DSTATCOM. The modeling and simulation is done in MATLAB. The results are validated and verified.

086	Investigations on recovery of apparent viscosity of crude oil after magnetic fluid conditioning
------------	--

A.D. Kulkarni¹[0000-0003-4704-381X]* and **K. S. Wani**²

¹Department of Petroleum and Petrochemical Engineering, Maharashtra Institute of Technology, Pune, India

²Department of Chemical Engineering, SSBT College of Engineering and Technology, Jalgaon, India

*anand.kulkarni@mitpune.edu.in

The reduction in viscosity of crude oil due to magnetic field and its subsequent recovery after certain time is an important method of paraffin wax deposition control. It is less energy intensive than the commonly used heating method. Three crude oils with varying wax content were subjected to magnetic fields of strengths 1000, 3000, 6000 and 9000 gauss for one minute. Reduction in viscosity of the samples was recorded instantaneously. Thereafter the viscosity readings were taken at regular intervals of time and the trend for recovery of viscosity to its original value was observed. Investigations were performed with respect to changes in magnetic field on crude oils having different wax content. It was found that more was the initial reduction, slower was the regain of viscosity. A possible mechanism for recovery of viscosity has also been discussed. The knowledge of recovery trend would help the flow assurance engineer to predict the optimum number of pumping stations thereby conserving energy.

087	Investigation on Different Types of Electric Storage Batteries used in offgrid Solar Power Plants and Procedures for their Performance Improvement
------------	---

Anindita Roy^{1*}, **Rajarshi Sen**², **Rupesh Shete**³

¹Associate Professor, Pimpri Chinchwad College of Engineering, Pune 411044, India

²Adjunct Professor, Pimpri Chinchwad College of Engineering

³Post-graduate Student, Pimpri Chinchwad College of Engineering, Pune 411044, India

*anindita.roy@pccoepune.org

Electric storage batteries are the vital part of off-grid photovoltaic power plants which are widely used in most developing and under-developed nations of the world. Batteries are also needed for load leveling and frequency voltage stabilization in grid connected solar and wind farms. More than 10,000 numbers is the estimated number of off grid battery based large and small community solar power plants in India. Almost all of these power plants and their batteries suffer from major capacity degradation within 5 years of installation although the design life of batteries with minimum 80% capacity retention is 8 – 10 years. This paper studies the capacity loss due to cycling in batteries used for solar power plant application through solar simulated laboratory tests. Through the tests, capacity degradation process could be simulated in laboratory conditions. It was found therefrom that the degradation pattern is different in different types of batteries. Further, the said degradation in capacity can be reversed through a servicing process termed as equalizing charge. The periodicity of equalizing charge has been determined for two major battery types used in solar power plants. The said equalizing charge process if done periodically can reverse the degradation due to cycling, thus extending the battery life to its design value of 8-10 years.

088

Optimum Location of SVC in an IEEE 33 Bus Radial Distribution System Using Power Sensitivity Index**Bharat Vardani^{1*}**¹Indian Institute of Technology Mandi, H.P. 175005, India

*bharatvardani1435@gmail.com

Voltage stability improvement is the burning issue in the present scenario due to an increase in the demand for electric power. Thus the most challenging task for the power engineers is to maintain the voltage stability and the voltage level at all important buses during stress condition in the power network. A number of different works have been reported by the previous researcher for voltage stability improvement using the Static Var Compensator (SVC). In the present work, an IEEE 33 nodes radial distribution system is considered and the voltage of each bus is taken care with the help of power sensitivity index. The present work depicts the optimum location of SVC which is a part of Flexible Alternating Current Transmission System (FACTS) device. This will improve voltage stability and Power flow of the entire power system network to a great extent. This work is justified with the help of Power System Analysis Toolbox (PSAT) toolbox in MATLAB/Simulink 2016a.

089

Saving electricity, one consumer at a time Lessons from Vidyut Rakshaka, a consumer-focused energy conservation and energy efficiency initiative**Ravichandran¹, Sumathy Krishnan^{1*}, Santhosh Cibi¹, Sumedha Malaviya²**¹Technology Informatics Design Endeavour, Bangalore ²World Resources Institute India, Bangalore

*k.sumathy@tide-india.org

This paper provides long-term field evidence from Bangalore on a possible low investment pathway for demand side management by enabling household consumers to take control of their electricity consumption. Conceptualized as a citizen-led program, 'VidyutRakshaka' aims to reduce electricity consumption of residential consumers in Bangalore. The strategy adopted is to provide nudges to consumers for behavior change along with recommendations to adopt energy efficiency. VidyutRakshaka is implemented by creating awareness, conducting surveys with voluntary participants, providing customized reports with social and monetary nudges. Analysis of consumption indicates a cumulative average savings of 22% for about 48% of the participants.

090

Study of effects of water inlet temperature and flow rate on the performance of Rotating Packed Bed**Saurabh¹ and D. S. Murthy¹**¹Department of Mechanical Engineering, College of Technology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar Uttarakhand, India 1 Corresponding Author

saturn2407@gmail.com

The study of gas-liquid contacting devices like rotating packed bed (RPB) gained impetus not only due to their promising capacity for volume reduction up-to 2-3 order in magnitude but also for process

intensification among the participating fluids through the packing. However, the thermal transfer phenomenon involved between the interacting fluids flowing in counter-current direction, due to centrifugal acceleration inside the RPB, is hard for discernment from experimental perspective alone. For this reason, CFD simulation has been undertaken in the present work to explore the effects of water inlet temperature and flow rate on the pressure, velocity, and temperature distribution inside the RPB domain. This communication aims towards achieving rigorous understanding of the multi-physics involved in the thermal process intensification pertaining to the RPB using air-water system. The heat transfer rate results bearing futuristic vision for replacement of fills structure in giant and voluminous conventional cooling towers using compact and efficient rotating packed beds are finally discussed.

091

Catalytic conversion of glycerol to biofuel additive using modified heteropolyacid

Sravanthi Veluturla¹, Archana Narula¹, Danwyn Jeethan Aranha¹, Akhil Pavadad¹, Sudarshan C.S

Department Of Chemical Engineering, M.S. Ramaiah Institute of Technology Bengaluru -560054

The tremendous growth of biodiesel production all around the globe has lead to production of large quantity of glycerol, the byproduct of biodiesel. The paper highlights on the aspect of valorization of biodiesel derived glycerol. Phosphomolybdic acid catalyst was synthesized by co-precipitation method and further modified with cerium nitrate and applied for the ketalisation of glycerol with acetone resulting in solketal, an oxygenated fuel additive. The catalyst characterization was done using XRD, FTIR and BET. Catalytic performance of Cerium Phosphomolybdic acid was studied by varying reaction conditions such as molar ratio, temperature and catalyst loading. Kinetic studies were investigated and Kinetic model was developed based on Langmuir Hienshel Wood Model. The activation energy was determined to be 25.9078 kJ/mol. This work helps in the continuous production of high value fuel additive from the glycerol

093

Synthesis, Characterization and Optimization of Glycerol carbonate from Biodiesel by product Glycerol using Mg based ZnO as Cheap and Efficient Heterogenous Catalyst

Gitanjali Pradhan* and Yogesh Chandra Sharma

Dept. of Applied Chemistry, Indian Institute of Technology (BHU), Varanasi.

*gitanjalipradhan504@gmail.com

Glycerol carbonate is one of the trending value added chemicals in biodiesel industry which extensively used in pharmaceutical, nutraceutical, cosmetic and food industries as well as green solvent in chemical industries. Depending upon the tremendous application of glycerol carbonate the synthesis of such compound from glycerol as by-product of biodiesel is the main focus of the researchers now a days. Several types of homogeneous as well heterogeneous catalysts are used for transesterification reaction of glycerol to glycerol carbonate. In this paper highly effective heterogeneous Mg based ZnO catalyst was synthesized by wet impregnation technique and applied for transesterification of glycerol with dimethyl carbonate to produce glycerol carbonate. The synthesized catalysts were characterized by several techniques namely XRD, SEM, FT-IR, TG-DTA,

BET surface area, Hammett indicator test and XPS. The transesterified product glycerol carbonate was simply monitored and also analyzed by both ¹H and ¹³C NMR Spectra and gas chromatography techniques (GC). Under optimized reaction condition of dimethyl carbonate to glycerol molar ratio of 4:1 catalyst loading amount of 3 wt% and reaction temperature of 800C; over 96.57% yield of glycerol carbonate product could be achieved within 2h.

094	Performance Assessment and Loss Forecasting of Grid Connected Solar PV System
------------	--

Sayed Imaad Quadri¹ and V.N Kalkhambkar²

¹Student, M. Tech. Power System, Rajarambapu Institute of Technology, Maharashtra

²V.N Kalkhambkar Rajarambapu Institute of Technology, Maharashtra

*imaadquadri72@gmail.com

#vaiju.kalkhambkar@ritindia.edu

The Yield and the loss forecasting of Solar PV System is a major factor for the planning and operation of grid connected solar PV system. Performance of the system depends on the design, horizon, orientation and geographical location of the solar PV panels. In this paper an equivalent model for 72 kWp on-grid solar PV system has been developed for a system which is installed at IRS Mumbai. Performance factors such as losses and Yield is forecasted using the PV Syst tool. The yearly as well as monthly data is simulated. The assessment for the forecasted data, is done by comparing the forecasted yield for October month with the actual data which is obtained from the inverter. For analyzing seasonal specific losses, forecasted data will be an important tool. Similarly, analysis of real time data with simulated data is basic requirement for calculating the error and the forecasting tolerance of the system.

095	An application of Long-range Energy Alternatives Planning (LEAP) software tool for developing energy models
------------	--

Archana Prasad^{1#} and Dr. Pankaj Kalita^{2*}

¹Centre for Rural Technology, Indian Institute of Technology, Guwahati

²Centre for Energy, Indian Institute of Technology, Guwahati

* pankajk@iitg.ac.in

#archa17415411@iitg.ac.in

Abstract. Energy is the backbone of a nation which connects economic and so-cial development with environmental sustainability. The energy modelling serves the purpose of exploring and shaping the future of developing countries and in-dustrialized countries. This study deals with the importance of energy modelling in a developing country like India where the demand for energy in both industrial and agricultural sectors has been growing due to the developmental activities. Main aim of the study is to apply LEAP (Long-Range Energy Alternatives Plan-ning System) software tool for modelling energy requirements for the state of Assam. LEAP is a widely-used software tool for energy policy analysis and cli-mate change mitigation assessment. Developed at the Stockholm Environment Institute, it has a bottom-up as well as top down approach of modelling in a way it has a hybrid modelling approach. The energy demand for cooking sector in the households of Assam is analyzed and modelled, in this study, also their environ-mental loadings are observed. This study can widely

help researchers, government bodies and policy makers in long term energy demand supply assessment and policy formation.

096

Performance evaluation and economic analysis of in-clined solar dryer for carrot (*Daucus carota* L.) drying

A.K. Singh^{1*}, Surendra Poonia² and Dilip Jain³

Division of Agricultural Engineering and Renewable Energy, ICAR-Central Arid Zone Research Institute, Jodhpur, India.

*akcazri@yahoo.co.in

This research paper describes the performance evaluation and economic analysis of solar dryer for drying of perishable agricultural produces. The dryer was fabricated using local-ly available materials, e.g. galvanized iron sheet, M.S. angle, glass and S.S. wire mesh. The provision of tilting the dryer helps receive maximum solar radiation round the year at Jodhpur, India and optimally inclined surface receive 22.8% more solar radiation as compared to horizontal surface. Therefore, optimally tilted solar dryer has been used for this study. The drying trial for dehydrating carrot (*Daucus carota* L.) was conducted in this dryer during February 2018. During the performance evaluation, the maximum stagnation temperature inside the drying chamber was observed 68°C and on loading with 8 kg carrot it reduced to 58°C, while outside ambient temperature was 37°C on a clear sky day (from 08:00 h to 18:00 h) in the month of February, 2018. During the drying process, moisture content of carrot was reduced from 74% (wet basis) to about 13% within 3 days. The efficiency of the dryer was found to be 17.57 %. The economic evaluation of the solar dryer revealed that high value of IRR (84.4 per cent) and low value of payback period (1.42 years) make the dryer unit very cost efficient. The economic indicator cost-benefit ratio was found 2.09, which shows the potential of using solar dryers in place of conventional dryers. The economic attributes namely net present worth (₹ 41830) and annuity was (₹ 5635) of the system revealed its economic viability. The use of inclined solar dryer in remote locations/rural areas can go a long way in reducing post-harvest losses as well as carbon emission. The use of solar dryer will be a great boon for farmers of arid region of Rajasthan.

097

Integrated Thermal Analysis of an All-Electric Vehicle

Vinayak Kulkarni and Shankar Krishnan*

Department of Mechanical Engineering, IIT Bombay, Mumbai-400076, India

*kshankar@iitb.ac.in

Simulation of electric vehicle is essential to analyze vehicle parameters and vehicle components. Components like battery, power electronics and electric motor needs to be below specified temperature range in order to operate safely and efficiently. Simplified first order simulations to estimate vehicle range and energy consumption along with component temperature variation for a specified driving cycle was completed. "Backward" faced simulation method is used to calculate traction force, total power, battery current, state of charge(SOC) serially in a direction opposite to power flow. Output parameters like range and energy consumption per 100km obtained from simulations compared against first generation Chevrolet Volt specifications. A lumped capacitance based thermal model was derived to predict temperature of vehicle components. Heat loss in

component estimated based on simplified drivetrain model assuming constant efficiency of electric motor and power electronics. Ongoing model improvements are listed to get more accurate and reliable results.

098

Comparative Analysis of SP and TCT Interconnection Schemes to enhance Power Generation of Solar Photovoltaic Arrays under Partial Shading Conditions

Sumit Verma^{1*}, Smita Pareek^{2#}, Nitin Chaturvedi^{3\$} and Ratna Dahiya^{4@}

^{1,2}EE Department, BKBIET Pilani, Rajasthan, India

³EEE Department, BITS Pilani, Rajasthan, India

⁴EE Department, NIT Kurukshetra, Haryana, India

* smithvrma@gmail.com

smita.pareek@bkbiet.ac.in

\$ nitin80@pilani.bits-pilani.ac.in

@ ratna_dahiya@nitkkr.ac.in

One of the major challenge in using solar photovoltaic array is to deal with its non-linear characteristics. The characteristics get more complex when the array is under partial shading condition. In large photovoltaic installations, partial shading is a common phenomenon due to nearby tree, pole, chimney etc. As a result of this, the received power is less than the expected output power. The effects of partial shading on power production of photovoltaic array may be reduced by altering the interconnections of photovoltaic array. Even if many interconnection schemes have been reported so far, the most exploited are SP and TCT interconnections. This work presents a detailed comparative performance analysis of SP and TCT interconnections of photovoltaic array under partial shading conditions to get the best topology for various easy-to-predict shading patterns. TCT is reported to perform better in comparison to SP under partial shading condition. However there are several partial shading condition in which SP yields more output power. In these cases, we propose to use SP in comparison to TCT to avail the advantage of fewer interconnections and reduced partial shading losses over TCT and thus to reduce complexity, wiring time etc.

099

Thermo hydraulic performance analysis due to angle of attack in V-rib with symmetrical gap roughened duct of solar air heater

Mohammad Dilnawaz Azmi

mdilnawaz1234@gmail.com

To overcome the low heat transfer coefficient between the hot surface and air roughness is provided on the heat transferring surface that disrupts the boundary layer over the heated surface and enhances the turbulence intensity over it. In the present research the analysis of thermohydraulic performance has been carried out of solar air heater duct roughened with V-rib with symmetrical gaps. The gaps are provided on the V-ribs that enables in breaking the thermal boundary layer. The experimental investigation of solar air heater rectangular duct comprises of the roughness parameters viz. number of gaps (N_g) of 3 and relative gap width (g/e) value of 4, relative roughness pitch (P/e) is taken as 10 and angle of attack (α) ranges from 30° to 75° are selected for testing. The flow Reynolds number is varied from 4000-18000. The maximum value of thermohydraulic performance parameter was observed for $\alpha=60^\circ$, $N_g=3$ and $g/e=4$.

100

Computation of Higher Eigenmodes using Subspace iteration scheme and its application to Flux Mapping System of AHWR**Anupreethi B^{1*}, Anurag Gupta^{1,2#}, Umasankari Kannan^{1,2\$} and Akhilanand Pati Tiwari^{1,3@}**¹Homi Bhabha National Institute, Mumbai, India²Reactor Physics Design Division, Bhabha Atomic Research Centre, Mumbai, India³Human Resource Development Division, Bhabha Atomic Research Centre, Mumbai, India

*anupreethi@barc.gov.in

#anurag@barc.gov.in

\$uma_k@barc.gov.in

@aptiwari@barc.gov.in

This paper presents the computation of fundamental and multiple higher eigenmodes of a reactor using Subspace iteration scheme. This scheme generates a large set of dominant eigenmodes simultaneously instead of successive evaluation of higher eigenmodes. Using this set of eigenmodes and in-core detector measurements, a three-dimensional flux map of a reactor configuration can be estimated. In this paper, the Subspace Iteration (SSI) scheme is used to generate multiple higher eigenmodes simultaneously for conventional as well as modified Flux Mapping Algorithms (FMAs). An Improved Modified Flux Synthesis Method (IMFSM) has been proposed which uses few higher eigenmodes of the snapshot configuration generated from SSI to better estimate the three-dimensional flux distribution of a reactor. Performance of various flux mapping schemes have been studied for Advanced Heavy Water Reactor (AHWR) by varying the set of flux modes and the number of in-core detectors.

101

Multiple Distributed Generation units in Distribution Network with Change of Load**S. Vijender Reddy*, M. Manjula**

Department of Electrical Engineering, University College of Engineering (A)

Osmania University, Hyderabad-007, Telangana, India,

*simarlavijender@gmail.com,

The paper explains the calculation of voltages and power losses in a Distribution Network(DN) with change of load by connecting multiple Distributed Generation(DG) units in DN. Firstly, the optimal location of DG units and size of DG units are determined using Ant Colony Search Algorithm (ACSA) at full load. Once the DG units are placed in these locations, the voltages and power losses are calculated at various buses with change of load. It is essential to observe the change of voltages because The voltage is one of the inequality constraint in power system. As the load changes, the power losses of DN also change with multiple DG units in DN. In this paper the voltages and power losses of DN are shown with change of load by connecting 10 DG units. ACSA is used as solving tool. An algorithm for ACSA programmed in MATLAB. The proposed ACSA method is implemented on an IEEE-85 bus DN.

102

Novel synthesis of Al₂O₃ nanoflakes for Ni-Al₂O₃ composite solar selective coatings**M. Shiva Prasad, K. K. Phani Kumar, S. R. Atchuta, T. Vijayaraghavan, B. N. V. Sudhakar, S. Sakthivel**

Centre for Solar Energy Materials, International Advanced Research Centre for Powder Metallurgy and New Materials, Balapur P.O., Hyderabad - 500005, Telangana, India

Spectrally selective absorber coatings (SSACs) play an important role in converting ambient electromagnetic radiation into heat for solar thermal applications. Metal-dielectric selective coatings are, one of the appropriate selective absorbing structure which exhibit low emittance with the help of metal reflectors while establishing high absorption of solar radiation with the aid of dielectric materials. A cost-effective Ni-Al₂O₃ metal-dielectric SSACs has been developed by a wet chemical method. High crystalline Al₂O₃ nanoflakes were synthesized by a solvothermal method and used the same to develop Ni-Al₂O₃ composite coating in sol-gel route. Characterization techniques such as XRD, FESEM, TEM were used to study the properties of coatings and Al₂O₃ nanostructures. The coatings developed under a Hydro-gen atmosphere with optimum concentrations of Ni and Al₂O₃ exhibited optical properties of absorptance 0.80 and emittance of 0.17 and the absorption further enhanced by 2% with the aid of an anti-reflective layer on top of the base absorber layer. These optical properties indicate potential application in concentrated solar thermal power applications.

103

Energy Conservation & Management in an Power Transmission Conductor Manufacturing Plant**Avinash Yadav^{1*}, Ramola Sinha² and Prashant Jain³**¹ Department of Mechanical Engineering,²K.J Somaiya College of Engineering, Mumbai, India

*avinash.ry@somaiya.edu

The Industrial sector account for highest electricity consumption in India with a share of around 42% of total consumption. Towards the path of development, India is witnessing rapid progressing in industrial development due to which there is increase in energy demand. The increasing energy demand has forced the energy cost to rise. This energy cost is an important factor in manufacturing industries as it is directly associated with the cost of the product. Thus, energy efficiency improvement is an important factor in reducing the manufacturing cost and increase the earning in this highly competitive market. In order to optimize the energy input in manufacturing process variety of opportunities are available at individual plant level, Component level. Realizing the importance of energy conservation in industrial sector, various studies in different countries have been taken up in several industries with a focus of energy conservation and management. This studies shows energy consumption, production trend, energy waste and energy conservation opportunities available in the industries by adapting suitable measures. This report is based on energy analysis of a power transmission conductor manufacturing unit in Gujarat as a case study. A detailed energy analysis of the industry was carried out to identify the area of energy consumption, energy waste and area of improvement with recommended measures to enhance energy usage. Based on this energy audit, conservation measures that can be implemented at process and component level of a manufacturing process are suggested with expected saving in energy & energy cost. Typical measures in process optimization are provided with payback periods and reference to further information on the same. Further research can be taken on the economics of suggested measures for similar industry and their suitability to different production facility.

105

ESCO model for energy efficient pump installation scheme: A case study**Saurabh Khobaragade, Priyanka Bhosale and Priya Jadhav**Centre for Technology Alternatives for Rural Areas,
IIT Bombay, Mumbai, India

Agricultural usage forms a significant portion of approximately 20% of the electricity consumption in India, most of it through irrigation pumpsets. Studies have shown that less than 2% of irrigation pumpsets have efficiency greater than 40%. To tap into this huge energy saving potential, various projects have been implemented under AgDSM (Agriculture Demand Side Management) in the last four decades. Pump replacement is one such initiative being given renewed focus by Energy Efficiency Services Limited. One model involves an ESCO or Energy Service Company that installs and maintains pumps, and gets paid based on energy savings. We investigate this business model through a recent project. The government implemented a pilot pump replacement and maintenance project in Solapur from 2010 to 2017. Though the Solapur project is claimed to be a success, there is no formal document publicly available yet. The aim of this study is to gain an understanding of the feasibility of a third-party maintaining energy efficiency in agriculture. The model is analyzed on technical, financial and social aspects. We investigate the basic financials, the monitoring and verification process used to measure pump efficiency in the field, the loading of the system and resultant voltages, and the effect of farmer behavior. We find that the methodology used for energy savings has much ambiguity and hence the scheme does not truly test the ESCO model. We also find that farmer education and awareness building regarding pumping systems is important for the success of such a scheme.

107

Implementation of Multilevel Inverter for Harmonic Reduction in Solar PV Application**Sagar Ananda Yadav^{1*} and Dr. Chetan B. Khadse^{2**}**¹Student, M.Tech. Power System, Rajarambapu Institute of Technology, Maharashtra²Department of Electrical Engineering, Rajarambapu Institute of Technology, Maharashtra

*yadavsagar228@gmail.com

**chetan.khadse07@gmail.com

In this paper, implementation of simulation based method for harmonic reduction in solar operated system, MATLAB Simulink Software is used to do simulation. T.H.D. analysis is carried out not only for output load voltage but also for Active and Reactive Power. This proposed work presents the design and implementation of novel multilevel inverter technique for the solar panel. For Conversion of Voltage from DC to AC two level cascade inverters are mostly used. This two level inverter can only able to produce two different outputs or level of voltages. But THD of 2-level inverter is not so good i.e. very high, because an output voltage waveform is in the form of two levels only, to limit and reduce THD value here new multilevel inverter is presented with less number of switches. THD analysis of conventional two level and new multilevel inverter is also presented here. Pulse width modulation technique is used and explained in details. The desired AC voltage is synthesizing by using various levels of DC voltages source.

108

Performance Evaluation of Gasifier Type Biomass Cookstove Models: An Experimental Study**K. Pal¹*, Nidhi Tyagi² and S. K. Tyagi³**¹Department of Chemical Engineering, R. N. College of Engineering & Technology, (An unit of PKG Group of Institutions) Madlauda, Panipat-132103, Haryana, India²R.B.S Engineering Technical Campus, Agra 283105 (Uttar Pradesh), India³Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India

*kunwarpal07@gmail.com

Biomass cookstove is used for cooking and space heating applications since ancient times in most of rural areas around the world. The traditionally developed cookstoves such as U-Shape mud cookstove and three stone fire stoves are very inefficient and can only transfer 10-15% of the energy available in the biomass fuels to the cooking pot. Besides, they release the product of unburnt pollutants into the environment which are health hazardous and assist the climate change. Further, the emission released from the cookstove affect the cook and there family members particularly, the children below 5 years of age. In the present study energetic and exergetic evaluation of two gasifire type cookstove model has been presented. These cookstove models were designed and developed by the group over the past few years. Further, the exergy analysis of these biomass cookstoves was carried out to understand the different losses which could not be understood properly using the energy analysis. From the findings, it has been concluded that the exergy analysis can be used as a new scientific tool for the development and evaluation of biomass cookstoves. It is also found that the exergy analysis in the development of improved cookstoves can be helpful for their better design in terms of high performance, convenience of use and low cost in long run.

109

Transient numerical model for natural convection flow in flat plate solar collector**Nagesh B. Balam¹*, Tabish Alam¹ and Akhilesh Gupta²**¹ CSIR-CenratlCentral Building Research Institute, Roorkee 247667² Indian Institute of Technology Roorkee, Roorkee 247667

*nagesh.balam@gmail.com

Natural convection flow in the annulus air gap of a flat plate solar collector constitutes the majority of heat losses in the solar collector. Here we report the development of a numerical model to simulate the transient behaviour of natural convection flow in the solar collector. The model is validated against benchmark results available in the literature i.e. Vahl Davis et. al. [17] and Samdarshi et. al. [18]. An error of less than 13% is observed for the top heat loss coefficient parameter of flat plate solar collector in comparison with these benchmark results. We report the natural convection flow for a particular case to evaluate the ability of the transient model to simulate the natural convection flow. Various structural and material parameters of the solar collector could be optimized using this transient model

110

Rice Paddy as a Source of Sustainable Energy in India**Mohnish Borker^{1*} and Suchithra T.V.²**¹Padre Conceicao College of Engineering, Verna-Goa, India²National Institute of Technology, Calicut-Kerala, India

*mohnish.borker12@gmail.com

The advancement of a microbial fuel cell, a plant microbial fuel cell acts as a source of sustainable bioelectricity generation. Apart from incorporating green plants, the fuel cell produces in-situ bioenergy thus conserving the ecosystem. Over the past decade, a lot of technological innovations have been exploited to find different models of the PMFC for effective outcomes. On the same note, various plant species are tried and tested. India being an agricultural land highly depends on rice paddy. The vast paddy fields can prove to be a unique source of bioenergy by incorporating in the PMFC. In this study, rice paddy was used in three different PMFC models. The adaptability of the plant to the model is tested and it achieved a high-power density of 1.048 W/m² anode geometric area in a dual chambered PMFC. Other proof of claim tests was conducted and the microbial activity in the PMFC media was studied.

111

Cost and Emission Trade-offs in Electricity Supply for the state of Maharashtra**Pankaj Kumar^{1*}, Trupti Mishra², Rangan Banerjee³**¹Interdisciplinary Programme in Climate Studies, IIT Bombay, Mumbai, India²SJM School of Management, IIT Bombay, Mumbai, India³Department of Energy Science and Engineering, IIT Bombay, Mumbai, India

*pankaj.k@iitb.ac.in

This paper analyzes synergies and trade-offs cost and emission minimization strategies for electricity supply for the state of Maharashtra. We developed an optimization model in TIMES framework with data of all power plants for Maharashtra in January 2019 to analyze dispatch. The cost and emission minimization scenarios are compared in terms of operating units, cost of electricity, emissions and age of units. We find that emissions from thermal power can be reduced by 9.2 percent in emission minimization with respect to cost minimization on the day of operation without any technological changes. The cost of electricity increases by 30.8 percent from 2.40 Rs/kWh to 3.14 Rs/kWh in emission minimizations scenario with respect to cost minimization. The cost of carbon abatement is 8827 Rs/tonne which is much higher than cost of carbon³ in most of developed countries. Emission minimizing operation requires additional Rs 269 Mn per day. This additional cost of cost of operation for emission reductions can be helpful in identifying and prioritizing cleaner power plants for electricity generation.

112

Photoelectrochemical water splitting activity enhancement of LaFeO₃ photocathode using plasmonic Ag nanoparticles**Volga Muthukumar¹, Srinivas Reddy², Asif Ali Tahir³, and Govinder Singh Pawar³, Bala Pesala^{1*}**

¹CSIR - Central Electronics Engineering Research Institute (CSIR-CEERI), CSIR Madras Complex, Chennai, India

²Indian Institute of Technology, Madras, Chennai, India

³Environment and Sustainability Institute, University of Exeter, United Kingdom

*balapesala@gmail.com

The strategy to the success of hydrogen generation using photoelectrochemical (PEC) water splitting lies in the development of high performance photocathodes. One of the main factors which hinder the development of efficient photocathodes is their limited and low light absorption capacity. In this work, the afore mentioned issue is addressed by incorporation of Ag plasmonic nanoparticles onto the photo electrodes which play a significant role in enhancing visible light harvesting by Localized Surface Plasmon Resonance (LSPR). In this study, uniform size silver nanoparticles (Ag NPs) were used to enhance the light absorption ability of the LaFeO₃ (LFO) photo-cathode. Ag nanoparticles of uniform size (57 ± 3 nm) were successfully synthesized by seed mediated technique using tannic acid and sodium citrate as reducing agents. The synthesized Ag NPs were spin coated at different concentrations on the LFO photocathodes and photoelectric activity was analyzed using a three electrode setup under solar simulator. The optimum concentration silver nanoparticles coated LFO showed more than 1.7 fold enhancement in activity at 0.6 V vs. RHE compared to plain LFO. The enhancement in activity is ascribed to the better light harvesting due to SPR effect of Ag nanoparticles.

114

Technological Interventions in Sun Drying of Grapes in Tropical Climatic for Enhanced and Hygienic Drying

Mallikarjun Pujari¹, P.G. Tewari², M.B. Gorawar³, Ajitkumar P.Madival⁴, Rakesh Tapaskar⁵, V.G.Balikai⁶, P.P. Revankar^{7*}

^{1,2,3,4,5,6,7} School of Mechanical Engineering, K.L.E.Technological University, Hubballi.

* pp_revankar@kletech.ac.in

Agriculture has been the backbone of Indian economy on account of its prominent gaining place in the socio-economic development of the nation. The untimely rains and over-exploited groundwater has disturbed ecology balance making water as a scarce resource. The use of renewable resources for power and process heat needs can help mitigate ecological imbalance due to fossil fuel burning. The farm energy needs arise on account of irrigation, post-processing and transportation activities. This reported study envisages technical interventions into the adoption of solar energy to dry agricultural produce for reduced wastages of produce and better pricing through enhanced storage-life. The fossil fuel usage for major energy needs poses a threat to current fuel reserves, also leading to environmental degradation. The obvious strategy for energy users has to be a blended energy usage pattern with a substantial renewable segment essential to make it sustainable. Every drop of fossil fuel burnt leaves behind an environmental mark termed as 'carbon-footprint'. Sustainability stresses minimizing environmental damage through adoption of green technologies also identified as renewable or nature-based sources. The chemical pretreatment in drying of Thomson seedless grapes by free convection was reported to provide suitable drying characteristics, but with scope for few modifications to improve drying rate.

115

Electricity generation from hydrogen and oxygen gas using PEMFC

Abhi Soni^{1*}, Naim Memon^{2}, Hiralkumar Morker³**

¹Chemical department Sarvajanic College of Engineering and Tehcnology Surat, India

²Chemical department Sarvajanic College of Engineering and Tehcnology Bharuch, India

³Chemical department Sarvajanic College of Engineering and Tehcnology Surat, India
harshitmorker10@gmail.com

*soni.abhi705@gmail.com, **naimmemon15@gmail.com

Hydrogen holds the greater potential of energy for combustion or other uses. Storage of hydrogen is most costly part to use it; therefore continuous flow of it is preferable for better optimum results. Electricity generation from hydrogen and oxygen is using fuel cell is most economical for development and also it reduce harmful byproduct gases as green technology.

116

Effect of Temperature on the Hydrodynamics of Steam Reactor in a Chemical Looping Reforming System

Agnideep Baidya, Saptashwa Biswas, Avinash Singh, Debodipta Moitra, Pooja Chaubdar and Atal Bihari Harichandan

KIIT Deemed to be University, Bhubaneswar, Odisha, India – 751024.

A cost effective carbon capture and storage process has been addressed by using a three-reactor chemical looping reforming technology (CLR) that produces hydrogen in an innovative manner. Ansys FLUENT is used to model the steam reactor based on kinetic theory of granular flow. A user defined function has been implemented for customizing the reactive fluid dynamics system by incorporating the oxidation kinetic of the metal oxide. In the current work, iron-oxide and manganese-oxide are used as oxygen carriers with steam as the fuel for the reaction kinetic model. The development, upsurging, growing and bursting of bubbles in the steam reactor are observed. Unsteady and quasi-steady bubble-hydrodynamics in steam reactor are captured through numerical simulations and the relationship between molar fraction of products and gas phases and bubble formation are investigated at different temperatures. Solid volume fraction contour has also been qualitatively compared with similar results available in open literature.

117

Enhancement in Product Value of Potato Through Chemical Pre-treatment and Drying Process

M.B. Gorawar¹, S.V. Desai², V. G. Balikai³ and P.P. Revankar^{4*}

^{1, 3, 4} School of Mechanical Engineering, KLETU, Hubballi.

² Department of Biotechnology, KLETU, Hubballi.

*pp_revankar@kletech.ac.in

The large magnitude of the post harvest losses in the agricultural sector has been a serious concern to the Indian economy. The Indian agriculture supports large population base, however with lower return on investment owing to uncertainties in yield and revenue accrued by the cultivators. This resentment like situation in the farming community taking extreme steps of direct danger to the social fabric of the nation. The interventions are thereby essential to control this menace and instill a confidence building movement in support of farming community. This work targets on evolving an improvised method to enhance the end value of potato crop through hygienic drying. The trails on

sliced potato as treated and untreated samples subjected to electric drying using air as heating media were conducted. The results for 0.4 kg sample suggested that inlet air at 100 °C and 0.025 kg/s flow yielded fastest drying rate of 4.5 h. The product hygiene investigated for food quality indicated permissible limits without any prevalence of fungi in the chemically treated product.

118

Desalination Using Waste Heat Recovery with Active Solar Still

Sandeep Kumar Singh, S. K. Tyagi*, and S. C. Kaushik

Indian Institute of Technology Delhi, New Delhi, 110016, India

*tyagisk@ces.iitd.ac.in

Water plays a vital role in human life. The human body consists of 70-80 % water in which body, bones, cells, and blood contain 22 %, 95 %, and 75 % water, respectively. Water and energy are imperative entities for flourishing life and civilization. Population growth, rapid industrialization, fast-growing agriculture sector leads to ineffective use of water and pollution of very less available water resources. Most of the states in India depends upon the groundwater hence facing the problem of excessive salinity, fluoride content and heavy amount of nitrate. As per the WHO guidelines, most of the state's drinking water is un-potable. As per the Government of India census report, nearly 75.1 % household still use solid fuel for biomass cookstove. Desalination of this polluted water using renewable energy is the only option to make this water potable. At a big scale, there is a major expense in desalination. The solar energy integrated with the waste heat of pellet based cookstove will be able to run the desalination system during off shine hours. This hybrid system will be able to enhance the productivity of the solar still. In the present work, simulation has been carried out to find the optimum water jacket thickness and mass flow rate of water to recover the waste heat from cookstove. The heat loss from the outer surface of the cookstove has also been calculated analytically.

120

Incorporating battery degradation in stand-alone PV microgrid with hybrid energy storage

Ammu Susanna Jacob^{1,2}, Rangan Banerjee¹, Prakash C Ghosh^{1*}

¹Department of Energy Science and Engineering, IIT Bombay, Mumbai 400076, India

²Center for Study of Science, Technology and Policy, Bengaluru 560094, India

* pcghosh@iitb.ac.in

Batteries are commonly employed as energy storage systems for PV stand-alone microgrid. The instantaneous, diurnal, and seasonal variation in load and PV generation degrades the battery rapidly. This affects the life cycle cost of the system. This paper aims to combine battery storage with supercapacitor (short-term) and hydrogen storage (long-term) and investigate and compare the reliability and annualised life cycle cost of the system with manufacturers given life and by incorporating battery degradation. The hybrid storage system is simulated for two stand-alone PV microgrid contexts, i.e., off-grid telecom tower and an off-grid welding shop. From the simulation results, it is obtained that battery degradation is lowered with the use of hybrid storage. Based on the reliability (loss of load probability) and per unit cost of the system the designer/consumer can select what type of storage combination will be suitable for the PV microgrid. As an example, the isolated welding shop with annual energy demand of 1408.5 kWh, the addition of supercapacitor improves

the life of battery from 2 years to 8 years, thereby improving life cycle cost of the system from 18 ₹/kWh to 13 ₹/kWh. In addition, the daily LOLP is reduced from 7.2% to zero.

121

Simulation Studies on Design and Performance Evaluation of SAPV System for Domestic Application

M. R Dhivyashree¹, R. P. Tapaskar², M. B Gorawar³, V.G.Bailkai⁴, P. P.Revankar^{5*}

^{1,2,3,4,5} School of Mechanical Engineering, KLE Technological University, Hubballi 580031

pp_revankar@bvb.kletech.ac.in

Energy is one of the crucial needs of the modern society. The dependency on the fossil reservoir has resulted in an unreparable harm to the earth's ecosystem. The demand of energy is increasing at an alarming rate due to growth in population and improved standards of living. Rural area is prone to loss of grid connectivity because of uneconomic capital involved in establishing transmission system to cater lower energy demands. Solar power generation is a key solution for off grid rural areas where reach of grid power supply is not feasible. Solar photovoltaic generation is one of the alternative sources of energy generation with the least impact on the ecosystem catering the societal energy demands. The source of photovoltaic generation is intermittent and subjected to the constraints like time of the day, season and sky conditions. The generation of such a system is non-linear and unpredictable. Hence there arises the need for predicting the output and behavior of the system before installation. The presented research elaborates the simulation studies carried out on standalone photovoltaic system using PVsyst for domestic application. The input site data and performance results of solar power generation system generated through simulation tool gives interesting operational strategies to predict the implications of a SAPV installation.

122

Investigating the production and performance of biodiesel blends from neem oil

Shubham Rawat¹, K Sai Sashank², Nilakantha Tripathy³, Gaurav Dwivedi^{4*}

¹ Department of Mechanical Engineering, Amity University Noida, India

^{2,3,4} School of Mechanical Engineering, VIT University, Vellore

*gdiitr2005@gmail.com

In the current scenario, fossil fuels are depleting rapidly, hence the non-conventional energy sources such as non-edible oils, biodiesel, hydrogen, bioethanol became the major area of interest for the scientist and engineers. These fuels have the potential to replace the conventional fossil fuels which are the major cause of environmental degradation and health problem. Not only this, but they can be used as the fuels for the future. But the non-edible oils cannot be used directly used in the engine due to its high viscosity, high density, high flash point and low calorific value. So, it needs to be converted to the lower viscosity fuel with the property comparable to the conventional diesel. One of the prominent methods for converting biodiesel from non-edible oil is transesterification. The neem oil contains a large amount of free fatty acids; hence it requires two-step transesterification process, first with acid and then with the base. After the transesterification, we will get biodiesel and glycerol as the product. It was found that fuel properties such as kinematic viscosity to be 3.6 centistokes. Biodiesel used in the engine at varied load, the brake specific fuel consumption (BSFC) for biodiesel and its blends are higher than the mineral diesel and the brake thermal efficiency (BTE) for the blends decreases. This experiment revealed that the blends for biodiesel can be used without any modification.

123

Numerical Investigations on the Flow Characteristics in a Compression Ignition Engine with Vortex Tube at Inlet**Sirajuddin S and Manimaran R***

SMBS, VIT University Chennai Campus, Chennai 600127

*manimaran.nr@gmail.com

Improvement in the performance of CI engine could be possible by enhancing the mixing of air and fuel in the engine cylinder. This could be achieved by the addition of swirl improvement devices in the inlet manifold of the engine. The present study concentrated mainly on the addition of vortex tube to the inlet manifold of the engine and to analyze the flow characteristics of the inlet air during cold flow (suction stroke) in the engine cylinder using CFD simulations. The simulated and experimental results of temperature separation of vortex tube alone are quite well matched. Flow characteristics like total pressure, axial velocity, velocity magnitude, total temperature and flow direction of the inlet air are analyzed.

124

Investigation of tool temperature and surface finish by using vortex cooling**R. Udayakumar¹ and R. Manimaran²**^{1,2} School of Mechanical and Building Sciences, Vellore Institute of Technology, Chennai, India 600127

Abstract. Machining process is one of the major area of mechanical engineering. The heat generated during machining process having negative impact on tool life and the surface finish of the product. This heat can be easily dissipated by using a cutting fluid. But the environmental and health effects of conventional cutting fluids lead the researches on alternative cutting fluids and cooling technologies. Cryogenic cooling, compressed air cooling and minimum quantity lubrication are the most effective methods for heat dissipation during machining. Compressed air cooling by using vortex tube is an economical and easy method of cooling. In this paper the temperature distribution on the tool is measured and compared with the same for vortex cooling and flood cooling. The use of vortex cooling improved the surface finish of the product and the temperature distribution on the tool was very less compared to the normal cooling technology. Since compressed air is using for cooling, environmental issues due to the flood cooling is eliminated.

125

Development of a dynamic battery model and estimation of equivalent electrical circuit parameters**Sourish Ganguly¹, Subhrasish Pal² and Ankur Bhattacharjee^{3*}**¹International Institute of Information Technology, Hyderabad, India²Institute of Engineering & Management, Kolkata, India³Birla Institute of Technology & Science, Hyderabad, India

*a.bhattacharjee@hyderabad.bits-pilani.ac.in

This paper aims to develop a dynamic electrical equivalent model of a battery for the estimation of its internal impedance parameters. The results of the estimation include the parameters obtained as functions of the state-of-charge (SOC) of the battery. The parameter estimation methodology is performed with two different types of batteries (Vanadium Redox Flow Battery and Li-ion battery) for different nominal voltages to demonstrate the robustness of the model. A comparison of errors obtained in the responses of the model is carried out to demonstrate the efficiency of the proposed model and the applicability of the dynamic parameters inside the battery subsystem. The proposed model is a generalized one and can be very useful for designing efficient electrical interface for the battery storage with renewable energy sources, since battery modeling is the key to various battery storage system designs, especially in areas of renewable energy storage. Renewable technologies, such as solar or wind, does not produce a prolonged power output; and hence, electrical energy storage from a non-conventional energy source becomes essential.

126

Investigation of Catalytic Converter Performance with Thermal Energy Storage**G.A.Pise¹, M.R. Nandgaonkar², S.B. Bore³**¹Government College of Engineering Pune, Dept of Mechanical Engineering, Pune, India²Government College of Engineering Pune, Dept of Mechanical Engineering Pune, India³Government College of Engineering Karad, Dept of Mechanical Engineering Satara, India

The incomplete combustion in an IC engine leads to a number of incomplete combustion products like CO, HC, NO_x, particulate matter etc. These pollutants have negative impact on air quality, environment and human health which has led to stringent norms of pollutant emission. Catalytic converter is a device which is used to control the emissions from an IC Engine and its conversion efficiency mainly depends on its Catalyst temperature. Efficiency of conventional catalytic converters is very low at low temperature and close to zero during cold start & warming up period. Nearly 60-80% of engine emissions mostly HC and CO occur during cold start for first 300 sec operation. To reduce the cold start emissions of an IC engine many techniques have been invented among them use of the latent heat storage system (LTES) is one of the best methods to reduce emissions from IC engine. In the present work an investigation was made of a solution based on the use of Thermal Energy storage to keep the catalyst temperature high during off-operation periods. A phase-change material (PCM) with a transition temperature of 340 °C, which is slightly above the light-off temperature of the catalyst, was specially formulated and a system comprising a catalytic converter with Phase change material jacket is designed and tested. The experimental investigation is conducted for NO load, 25%, 50%, 75% & full load conditions. During the tests Catalytic converter inlet, outlet, Phase Change Material temperature & HC, CO emissions are

recorded.. During normal running condition TES stores the heat & main-tain the temperature of catalytic converter during engine OFF period, because of which emissions were reduced during starting of 2nd & 3rd transient cycles. Also, TES maintains the temperature of catalytic converter above 1000C for 340-350 minutes in full load conditions after engine is shut down.

128

A Novel Switched Inductor Switched Capacitor based quasi Switched Boost Inverter

P. Sriramalakshmi* and Sreedevi V.T.

Vellore Institute of Technology, Chennai Campus

*sriramalakshmi.p@vit.ac.in,

The power electronics plays a main role in interconnecting the renewable energy sources to the grid. This research paper discusses a novel switched inductor cell combined with a switched capacitor cell based quasi Switched Boost Inverter (SL-SC based qSBI) topology which can be used for renewable energy applications. This boost inverter topology is capable of providing a boosted AC voltage with high voltage gain and greater EMI immunity in a single stage compared to conventional Voltage Source Inverter (VSI). In addition, it does not require any dead time period in its switching states since shoot-through is permitted. Instead, shoot-through state is used to achieve a high boost. This paper presents the principle of operation, steady state analysis of the proposed inverter, modulation strategy adopted to produce the firing pulses and provides the performance comparison with the existing qSBI topologies. A single phase 113V (rms) load voltage is obtained with the dc source voltage of 32V and duty ratio of 0.22. It provides the boost factor of 6.4. The proposed topology is simulated in MATLAB/SIMULINK platform to validate the theoretical concepts and the results are presented in detail.

130

Investigation of Energy Performance of a High Rise Residential Building in Kolkata through Performance Levels of Energy Conservation Building Code, 2017

Gunjan Kumar¹, Biswajit Thakur² and Sudipta De^{1*}

1 Department of Mechanical Engineering, Jadavpur University, kolkata, 700032, India

2 Department of Civil Engineering, Meghnad Saha Institute of Technology, kolkata, 700150, India

*de_sudipta@rediffmail.com

The building sector in India consumes over 30% of the total electricity consumed in the country annually and out of that residential buildings consume about 75% of total electricity used by building sector. Further rise of multistoried buildings in urban areas with increased use of decentralized room-based air conditioning units add pressure on energy requirements for residential buildings. This increased demand also offer opportunity for energy saving and hence Bureau of Energy Efficiency has established Energy codes for new buildings as an essential administrative tool in order to ensure energy efficiency in the building sector. This paper aims to explore energy saving potential of high-rise residential building based on performance level approach of Energy Conservation Building Code (ECBC) 2017. The building models were designed as per ECBC guideline with focus on envelop and HVAC system. Energy performance analyses were carried out using e-QUEST energy simulation tool for actual design, ECBC baseline, ECBC+ and ECBC

super. The results revealed that the improved level of design help to reduce the space cooling load along with overall energy requirements of building. Further exploration of the energy performance of the residential buildings in light of the ECBC Residential Code is deemed necessary for better understanding of the process.

133

Addressing Last Mile Electricity Distribution Problems: Study of Performance of SHGs in Odisha

Sneha Swami¹ and Subodh Wagle^{*,1,2}

¹Centre for Policy Studies (CPS), IIT Bombay

²Centre for Technology Alternatives for Rural Areas (CTARA), IIT Bombay

*subodh.wagle@iitb.ac.in

Distribution of electricity becomes inefficient when rural areas are sparse or remote. Un-metered/illegal connections, poor bill collection efficiencies are the common practices found in villages, especially remote areas. Consumers also remain unsatisfied with service provided by Distribution Utility due to long hours of supply cut, unscheduled outages, low voltage levels and wrong meter readings. To address these problems at last mile and to improve the performance of electricity distribution sector, Electricity Act 2003 has introduced Distribution Franchisees (DF). DFs are contracted to manage the last mile functions of electricity sector for a specified area. This paper presents a study of an initiative by a DF in the state of Odisha, which gave contracts to 142 women SHGs to undertake metering, billing, and revenue collection, leading to reduction in electricity losses by 30%. The objective of the study is to gain deeper understanding of different aspects of the role played by SHGs in handing these last-mile governance functions. The study relies on semi-structured and unstructured interviews with different stakeholders. The study would help understand the feasibility and relevance of SHGs in addressing the governance crisis in the last-mile of the electricity sector.

134

Optimization of Trans-esterification Process for Biodiesel Production from Neem and Cottonseed Oil Mixture

Kunal Chaudhari*, Shantanu Patil, Pranjal Patil, Saurabh Khandebharad and Madhukar Tandale

Department of Mechanical Engineering

Dr. Babasaheb Ambedkar Technological University, Lonere 402 103

* kunalc2011@gmail.com

Fossil fuels are depleting rapidly resulting increase in the cost of pe-troleum fuels and emission of greenhouse gases over the years. One of the possi-ble intermediate solutions to this problem is usage of renewable sources of energy especially in transport sector. One such promising resource is Biodiesel. Bio-diesel is produced from vegetable oils by widely used chemical process called transesterification. Several researchers have carried out extensive research on various non-edible oil seeds like Jatropha, Karanja, Mahua, Cottonseed, Castor etc. showing promising results. Moreover, some of these resources are in com-mercial use. Biodiesel properties can be improved with mixture of non-edible oils. The present study is one such attempt for maximizing the yield of Biodiesel obtained by mixing Cottonseed oil and Neem oil for improving fuel properties. The chemical

process used is transesterification with methanol as a reactant and potassium hydroxide as a catalyst. Experiments were designed and conducted to determine the effects of reaction parameters such as methanol/oil molar ratio (6:1-8:1), catalyst concentration (1-2%), reaction temperature (55-65°C) for maximizing the yield.

135

Transient Stability Analysis of Wind Integrated Power Network using STATCOM and BESS using DlgSILENT PowerFactory

Neha Manjul* and Mahiraj Singh Rawat

National Institute of Technology Uttarakhand, Srinagar Garhwal, India, 246174

*nehamanjul1226@gmail.com

In this paper, the transient stability of wind integrated power system have analyzed with or without battery energy storage system (BESS) and static compensator (STATCOM) under large disturbances. The large penetration of wind energy into the power grid is the major challenge for reliable and stable operation of the system. The transient stability of such type of power systems can be improved by utilizing the BESS and STATCOM. In this paper, the large disturbances such as sudden change in load demand, three phase fault, sudden change in wind speed and wind gust has investigated. The energy storage system such as BESS is utilized with wind farm in order to modulate the fluctuations in power output. It also improves the response of synchronous generators to transient events. The paper also highlights the effective control of BESS and STATCOM for transient stability improvement. For validation of the proposed techniques, the IEEE 14 bus test system has utilized. All the simulation studies have been performed with DlgSILENT PowerFactory 2018.

137

Experimental Investigation of Solar Drying Characteristics of Grapes

S. P. Komble^{1,2}, Govind N. Kulkarni³, C.M. Sewatkar^{1*}

¹Department of Mechanical Engineering, College of Engineering, Pune, S. P. PuneUniversity, Pune, India

²Department of Mechanical Engineering, Vishwakarma Institute of Technology, Pune, S. P. Pune University, Pune, India

³Director, Anna SahebDange College of Engineering and Technology, Ashta, India

*cms.mech@coep.ac.in

This work presents solar drying characteristic of grapes using cabinet type solar dryer. In this study various analytical drying models were used to estimate the optimum drying time. Characteristics of grapes are expressed well by Newton model by thin layer models. This model has shows grape characteristics with drying air temperature from 34 to 52C and air circulation velocity of 0.4 to 0.9 m/s. Drying kinetics such as air temperature and velocity play an important role in the drying process. The time required for drying of grapes wasalso measured experimentally. The analytical estimate was 52 hours while the same was 56 hours experimentally. Drying rate depends predominantly on the drying temperature.

138

Feedback and Feedforward Control of Dual Active Bridge DC-DC Converter Using Generalized Average Modelling**Shipra Tiwari^{1*} and Dr. Saumendra Sarangi²**

1 National Institute of Technology, Uttarakhand

2 Motilal Nehru National Institute of Technology, Prayagraj

*shipra.tiwari.eee17@nituk.ac.in

The small signal approximations which are generally used in the dc-dc converters provide the limited range of operation which is around the steady state point. However, if the ripples are large, this approximation is generally not true for which the generalized average modelling is better to capture the effects of other harmonic component along with the dc component. Here, the author has employed the generalized averaging technique including the input and output side parameters using the feedforward and feedback control on the Dual Active Bridge Converter. The inductor current is alternating and to capture the behaviour of system parameters, the generalized average modelling is done. It is found that the input parameter will also affect the overall dynamics and using MATLAB/SIMULINK tool the overall analysis is validated.

139

Performance and Emission Characteristics of CI engine using lemongrass oil-diesel blend.**Mridul Ranjan Upadhyay*, Somnath Pal, Manikandaraja G**

SRM Institute of Science and Technology, Kattankulathur, Chennai, Tamilnadu, India

*mridulranjan_mukul@srmuniv.edu.in

Abstract. Increase in energy demand, stringent emission norms and depletion of oil resources led to finding alternative fuels for internal combustion engines. In this paper, we study the performance and emission characteristics of CI engine fueled with lemongrass oil Blended in the blending ratio B10, B20, B30 with 5% isobutanol and die ethyl ether. The Experiment was carried out in the four-stroke, single cylinder diesel engine by varying the load from 20% to 80%. The result shows that the addition of lemongrass oil increases the Brake thermal efficiency with a reduction in specific fuel consumption and exhaust gas temperature. An increasing amount of lemongrass oil in the blends also reduces the emission parameter such as CO, CO₂, NOX, and O₂ with an increase in the HC emission. The addition of isobutanol and die ethyl ether in the lemongrass oil blend diesel fuel has similar effect to that of addition of pure lemongrass oil in varying proportions, that increases the brake thermal efficiency with reduction in specific fuel consumption and exhaust gas temperature, the effect on the emission characteristics by addition of isobutanol and die ethyl ether results in a lower CO, CO₂, NOX and O₂ with an increase in the HC emission. The effective mixing of lemongrass oil and isobutanol yield a satisfactory result on the combustion characteristics at lower load which gets better on increasing the load.

141

Techno-economic evaluation of heliostat imperfections for low costs**A.N. Yerudkar¹, V.H. Dalvi^{1*}, S.V. Panse², J.B. Joshi¹**¹Institute of Chemical Technology, Department of Chemical Engineering, Mumbai 400019, India²Institute of Chemical Technology, Department of Physics, Mumbai 400019, India

*vishwanathdalvi@gmail.com

The heliostat field contributes about 50% to the cost of a power tower plant and the high initial costs associated with the heliostats is a major hindrance to the widespread deployment of solar thermal power plants. An intelligent approach to cost reduction requires a detailed understanding of the relation between costs and heliostat performance. Optical parameters like reflectivity, tracking, spillage; receiver properties like absorbance, emittance, etc.; material costs, storage cost, power cycle and tower cost, and other indirect costs all need to be incorporated into a detailed model. The utility of each of these factors is measured by the yearly average energy output. Two very important factors viz deformation and tracking errors can be modelled as an increase in the solar-width/spread. Since much of the cost of the heliostat is associated with minimizing these errors, we have undertaken in this paper, to calculate the relation between solar spread and heliostat cost. An in-house code was developed to calculate the yearly average thermal energy absorbed by the receiver for various solar spreads and concentration ratios and economic analysis was performed. The cost varies as a function of solar spread raised to the negative power. Thus, with the increase in solar spread, the cost decreases. Although the optical efficiency is compromised, a trade-off can be achieved by the inclusion of all the parameters for a detailed sensitivity analysis.

142

Performance assessment and parametric study of multiple effect evaporator**Pranaynil Saikia¹, Soundaram Ramanathan² and Dibakar Rakshit^{1*}**¹Centre for Energy Studies, Indian Institute of Technology Delhi²Deputy Programme Manager, Centre for Science and Environment, Delhi

*dibakar@iitd.ac.in

Multiple effect evaporators (MEE) use steam of temperature 120 – 200°C for evaporation of water. Conventionally the steam fed to MEE is generated by conventional fuel fired boilers, in the current study concentrated solar energy is employed as alternative. A system model was designed to study the temperature of steam generated on an hourly basis throughout the year and its exergy performance in different climatic zones of India. Except winter months and monsoon days, the solar concentrator generated the desired temperature of steam, thereby was not affecting the performance of the multiple effect evaporator system. Auxiliary support will be necessary during such durations to raise the steam temperature from 70°C to desired range. An hourly variation in solar radiations does not significantly affect the performance of the solar assisted MEE system. Influence of the system performance on varying parameters has also been studied using the model. Reynolds number (Re) of the waste water flow was found chiefly influencing the energy and exergy performance of the device, the change in Re can cause up to 60% variation in exergy and energy of the system.

145

Dynamic modelling of natural gas market based on impact assessment: An Indian case study**Vinod Vijay Kumar^{1,2,3}, Yogendra Shastri^{2,*}, Andrew Hoadley³**¹IITB-Monash Research Academy, IIT Bombay, Mumbai, India²Department of Chemical Engineering, IIT Bombay, Mumbai, India³Department of Chemical Engineering, Monash University, Melbourne, Australia

*yshastri@iitb.ac.in

As India strives towards achieving a low-carbon economy, it is expected that natural gas will play a significant role in the country's energy mix. However, with issues such as declining domestic reserves, rising import dependency, and a controlled pricing mechanism, the road ahead for natural gas might comprise challenges. This paper examines the potential demand for natural gas across different sectors by using a dynamic modelling approach. In addition, the wider environmental benefits that result from the penetration of natural gas in the cooking sector is also evaluated. Further, the long-term impact of reducing domestic gas is assessed by using the resource substitution methodology along with a dynamic resource-depletion indicator that is based on decision-making viewpoints for the environment. In this paper, imported liquefied natural gas (LNG) and imported pipeline gas are considered potential substitutes to domestic gas during scarcity. The gas penetration in the cooking sector resulted in a fall in the environmental impact indicator in the category of particulate matter formation by 78 %, 83 % and 87 % for the individualist, hierarchist and egalitarian viewpoints, respectively. At the same time, the increased dependence on imported gas, resulting from domestic shortage, caused an increase in the wider environmental impacts. The paper highlights the necessity and the prospects for natural gas in India. However, the growing demand for gas can only be met with an increasing dependence on imports.

146

An Approach Towards Sustainable Energy Education in India**Pankaj Kalita*, Rabindra Kangsha Banik, Samar Das and Dudul Das¹**¹Centre for Energy, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India.

*pankajk@iitg.ac.in

Renewable energy (RE) has been identified as an appropriate response to climate change and fossil fuel depletion by many governmental bodies. It has shifted the energy industry towards renewable and sustainable energy systems over the last few decades. This expansion has also increased the demand of specialists for design, installation and maintenance of different RE systems. Most people working in this sector are not well trained or educated enough whereas some of them are not even aware of sustainability. This has shifted towards formulation, model, develop and incorporation of new courses and programmes that would provide sufficient knowledge and skill in the sustainable RE sector. Moreover, implementation of these new RE courses shouldn't be limited to engineering level but also focuses on providing basic knowledge to everyone working in this field. Hence, in the present study, two course structures have been suggested i.e. general course which would offer basic knowledge and awareness of different RE systems in school level (including primary, elementary, intermediate and secondary) and in the professional programmes (Industrial Training Institute (ITI), diploma, undergraduate, postgraduate and research). Moreover, adequate knowledge would be provided not only in the theoretical field but also in the practical field depending upon the level of

programme. Furthermore, undergraduate, postgraduate and research levels students would be provided with broad knowledge of science, engineering design, planning and implementation of RE systems, while ITI and diploma level would acquire skill development and training in the RE systems.

147

Dielectric-Meta material Antireflection Coating for efficient transmission enhancement in CZTS/CdS Solar cell

K.S. Joseph Wilson^{1*}, M. Ismail Fathima¹, Zaheetha banu¹

Department of Physics, Arul Anandar College (Autonomous)

Karumathur, Madurai, Tamil Nadu – 625 514, India

*wilsonpra@yahoo.co.in

Artificial metamaterial's effective optical properties perform very essential role to reduce the reflective losses in the high efficient solar cell. Recent designs of Dielectric – Metamaterial composite have some advantages in improving the coupling effect of light in the visible region. It has been established that the Dielectric - Metamaterials Antireflection coating (DMARC) produce outstanding results. It dramatically reduces the reflection and greatly enhances the transmission over a wide range of incidence angles, in the visible region. Present theoretical work revealed the transmission effect with various substrate such as MgO/SiO₂/TiO₂/ZnO – Ag-MgF₂-Ag DMARC on CZTS/CdS Solar cell. This system may also be analysed with different incident angles using Transfer matrix method (TMM). It is found that solar cell with ZnO -Ag-MgF₂-Ag ARC provide the maximum light transmission in visible region at normal incidence. It is also found that the ZnO-Ag-MgF₂-Ag ARC design on CZTS/CdS Solar cell can lead to improve the quantum efficiency from 3.5 % to 22% at 400nm-700nm.

148

Simulation based Economic Optimization of Nuclear – Renewable Hybrid Energy Systems with Reliability Constraints

Saikrishna Nadella*, Anil Antony and N. K. Maheshwari

Bhabha Atomic Research Centre, Mumbai 400085, India

*nskrishna@barc.gov.in

Growing energy demands and concerns about environmental consequences of energy generation by conventional methods led to greatest ever focus on renewable energy worldwide. Due to technological advances, solar and wind power are almost reaching grid parity in recent years in various countries. However, the stochastic and unreliable nature of renewable energy sources poses problems with grid integration in case of large penetration. Hybrid Energy System (HES) combines two or more energy sources and energy storage elements to stabilize the supply, thereby increases the reliability. As nuclear power is carbon free, concentrated and continuous source of energy, it is an attractive option to meet base load demand as a part of HES. Such systems are called Nuclear Renewable Hybrid Energy Systems (NRHES). In this paper, a techno-economic model for simulation based cost optimization of NRHES is presented along with a case study to demonstrate the optimization process.

149

Exergy analysis and cost optimization of solar flat plate collector for a two stage absorption refrigeration system with water-lithium bromide as a working pair**Abhishek Verma, S.K. Tyagi* and S.C. Kaushik**

Indian Institute of Technology Delhi, New Delhi-110016, India

*tyagisk@ces.iitd.ac.in

In the present work, a thermodynamic analysis of a two stages half-effect absorption system has been done. The two stages half effect system is driven by the low temperature hot water provided by the FPC (flat plate collector). The area of solar FPC for LP&HP generator is optimized. The cooling load of 25 kW was assumed for an office building at Delhi. The area of FPC is minimized at the optimum generator temperature which is associated with the cost of HVARs. The cost of half effect system is compared with that of a vapour compression system with similar input parameters and the payback period is calculated. The optimum temperature for LP&HP generators is obtained to be 80°C. The maximum COP, exergetic efficiency and global efficiency obtained corresponding to the optimum generator temperature are 0.416, 7.36% and 18.7% respectively. For this generator temperature, 7°C evaporator temperature and 38°C condenser temperature, the minimum area required at HP stage is AHP (291 m²) and LP stage is ALP (346 m²) which is associated with the cost of HVARs. For the same input parameters, the running cost of VCRS (Rs.4 lakhs approx.) for a year is compared with the HVARs. The total cost of the FPC required is Rs.16 lakhs approx. This is the only cost which is considered to cool the given space. Therefore the payback period obtained is 4 years.

150

Characterizing the helical vortex frequency of HAWT**Ojing Siram¹ and Niranjana Sahoo²**¹Center for Energy, Indian Institute of Technology Guwahati 781039, India²Department of Mechanical Engineering Guwahati 781039, India

*osiram14@iitg.ac.in

To fulfil the growing energy demand with sustainable source and ensuring the preview of environmental friendly generation, Wind Energy plays a vital role in providing the same with eco-friendly perspective. In present era of high tech, booming industrialization, population growth and global collaborations, there is drastic increase in energy demand. Wind energy being the source of highest renewable energy in India has the ability to provide efficiently because of vast ability of wind flow across the globe. For large scale energy demand, designing and forecasting proper layout of wind farm is of great interest by many researchers and because of the unsteadiness in wind flow, annual flow variation, atmospheric boundary layer effects, seasonal climatic change and most importantly the effect of wake flow downstream of wind turbine in subsequent arrays of turbine makes the wind farm modelling a difficult task. So present article highlight the work carried out in wind tunnel defining the significance of tip vortex frequency response and velocity deficit near rotor plane further to understand the wake flow downstream of HAWT (Horizontal axis wind turbine) and subsequently designing of efficient wind farm for various flow conditions.

151

Design and Development of Concentrated Solar Cooker with Parabolic Dish Concentrator**Susant Kumar Sahu^{1*}, N. Sendhil Kumar² and K. Arjun Singh²**¹Raghu Engineering College, Visakhapatnam, 531162, India²National Institute of Technology Puducherry, Karaikal, 609609, India

*susantsahukit@gmail.com,

Renewable source is a green system for power generation without any impact on environment. In recent trends the applied solar energy devices become more popular near couple of decades. The main objective of the current research is to design and develop a concentrated solar cooker with a parabolic dish concentrator system at cheaper cost in order to save the environment by preventing burning of fossil fuel for cooking food. A parabolic solar concentrated cooker with capacity of cooking 645 gm of rice in 5 hours at peak solar has been proposed. The thermal efficiency of the cooking system has been evaluated and performance was studied in Visakhapatnam geographical location in south-east India. The experimentation is done in normal clear sky atmosphere on dated 27th February, 2019 in the area of Visakhapatnam located in latitude 17.68° N, 83.2185° E. The cooking procedure has been done in 3 cycles from 9.30 am to 3.30 pm.

152

CFD Simulation of Thermal Energy Storage for a Catalytic Converter**G.A.Pise¹, M.R. Nandgaonkar², S.B. Bore³**¹Research Student, Government College of Engineering Pune, Dept of Mechanical Engineer-ing, Pune, India²Professor, Government College of Engineering Pune, Dept of Mechanical Engineering, Pune, India³PG Student, Government College of Engineering Karad, Dept of Mechanical Engineering, Satara, India

Catalytic converters are used on most vehicles in world to meet the requirements of government mandated emission limits. The converter is comprised of a monolith type substrate, the surface of which is coated with a thin catalytic washcoat. The coated monolith is encapsu-lated in a can, which is placed appropriately in the exhaust system. There are many spatial configurations possible, which exhibit different flow and temperature patterns. The nature of the exhaust gas flow is a very important factor in determining the performance of the catalytic converter. Of particular importance is the pressure gradient and velocity distribution through the substrate. Hence CFD analysis is used to design efficient catalytic converters. By modeling the exhaust gas flow, the pressure drop and the uniformity of flow through the substrate can be determined. Here, reliable numerical simulations can serve as a powerful method to investigate and eventually optimize the performance of catalytic converters. Understanding the temperature and species profiles inside the converter is an important step in the development of highly op-timized catalytic systems. As temperature of an exhaust gas passing through catalytic converter is high, temperature distribution is also important. In present study temperature distribution in the catalytic converter is simulated and validated with experimental results.

154

Thermal and Electrical Performance Assessment of Elongated Compound Parabolic Concentrator**Chandan^{1,3}, Sumon Dey^{1,2,3}, V. Suresh², Md. Iqbal², K.S. Reddy⁴ and Bala Pesala^{1,2*}**¹Academy of Scientific and Innovative Research, Ghaziabad²CSIR-Central Electronic Engineering Research Institute, Chennai³CSIR-Structural Engineering Research Institute, Chennai⁴Indian Institute of Technology, Madras, Chennai

*balapesala@gmail.com

In this work, a non-imaging low concentrating 3X Compound Parabolic Concentrator (CPC) truncated to 1.7X has been explored. Since, CPC is a linear concentrator, the linear image formed on the absorber results in non-uniform distribution of flux. To reduce the non-uniformity in flux distribution, an optimized homogenizer has been integrated with the CPC, referred to as Elongated CPC (ECPC). Thereafter, numerical model has been developed for predicting the thermal performance of the ECPC integrated with homogenizer using actual meteorological data (wind speed and ambient temperature). Finally, the system is fabricated, and its performance is evaluated under real world conditions. Experimental results showed a peak thermal efficiency of ~35 % and peak electrical efficiency of 10%. The outlet water temperature obtained from simulations and experiments shows a good match with variation of $\pm 2^\circ\text{C}$.

156

Smart Highways: Harvesting Electricity using speeding vehicles**Yashvi Thakkar, Faiz Palwala, Anisha Sai Sistla, Krithika Balasubramanian, Suhavi Singal, Animesh Aggarwal, Neelesh Gupta, Santhi V***

School of Computer Science and Engineering

Vellore Institute of Technology, Vellore, India

*vsanthi@vit.ac.in

This study deals with harvesting electricity using speeding vehicles and thus making facilitating towards smart highways. Considering the shortage of electricity and current rate of over exhaustion of fossil fuels, renewable resources need to be used efficiently to meet the current needs and future demands. The model proposed consists of a turbine which is attached to a generator which will further converts kinetic mechanical energy to electrical energy. There are various new mechanical designs and materials proposed for the turbine which will reduce the cost with the same efficiency. There is a safety circuit which will prevent any damage caused by certain voltage fluctuations and bidirectional rotor motion. This is further connected to a charging circuit and Arduino current sensor and Arduino voltage sensor which works on voltage divider rule. Nodemcu is used to log and store data on ThingSpeak API. This helps us in keeping a tab of certain parameters like current, voltage etc which can be used to charge a battery and transmit it to nearby villages, provide charging hubs on the highways and act as charging stations for electrically powered cars.

158

Thermodynamic Analysis of a 500 MWe Coal Fired Supercritical Thermal Power Plant Integrated with Molten Carbonate Fuel Cell (MCFC) at Flue Gas Stream**Akshini More, A. Pruthvi Deep and Sujit Karmakar***

Department of Mechanical Engineering, National Institute of Technology Durgapur, India

*sujitkarmakar@yahoo.com

India, being one of the largest emitter of CO₂ globally has a huge obligation to curb the emission levels and meet the International Agreements. In view of this, the proposed study integrates a Molten Carbonate Fuel Cell (MCFC) at cathode side in the flue gas path of a 500 MWe coal fired supercritical thermal power plant. High ash Indian coal is used as fuel in the present study. A gasifier is used to cater the syngas at anode side of the MCFC. Thermodynamic analysis of this combined cycle power plant is done using a flowsheet computer program 'Cycle-Tempo'. The results revealed an increase in the proposed plant energy efficiency by 2.53% and a decrease in the specific CO₂ emission by 11.07% compared to the standalone 500 MWe super-critical thermal power plant considered in the study. The thermodynamic analysis reveals that maximum energy loss and exergy destruction take place in the cooling water and combustor, respectively.

159

Influence of Fuel Injection Pressure and Injection Timing on Nano-Particle Emission in Gasoline/Diesel RCCI Engine**Mohit Raj Saxena, Rakesh Kumar Maurya***

Advanced Engine and Fuel Research Laboratory, Department of Mechanical Engineering, Indian Institute of Technology, Ropar, Rupnagar 140001, India

*rakesh.maurya@iitrpr.ac.in

This work investigates the influence of fuel injection events on the nano-particle emission characteristics of gasoline-diesel RCCI engine. The formation of nano-particle emissions strongly depends on fuel injection events. The present study experimentally investigating the influence of diesel injection pressure (IP), injection timing (DI), and port fuel injected mass on the nano-particles emitted from the gasoline-diesel RCCI engine. For this purpose, the engine is tested for different diesel DI, IP and different port fuel injected gasoline mass at fixed engine load of 1.5 bar BMEP. The particle-size and number distribution (PSD) and total particle number (total PN) concentration are measured using differential mobility spectrometer. The results depicts that the neat diesel operation has significantly lower particles emission for same diesel injection pressure in comparison to RCCI combustion. A nucleation as well as accumulation mode particle increases with advanced DI in RCCI combustion. Increase in port fuel injected mass also leads to an increase in the total particle concentration and total hydrocarbon (THC) emission.

160

Optimization of the size of solar energy Sensible heat storage system**Geetanjali Raghav*, Mohit Nagpal, Piyush Kumar**

1,2 Department of Mechanical Engineering, College of Engineering, University of Petroleum and Energy Studies (UPES), Energy Acres, VPO Bidholi, PO Prem Nagar, Dehradun 248007, Uttarakhand, India

3Department of Mechanical Engineering DIT university, village makkawala mussorie diversion road Dehradun 248007, Uttarakhand, India

*graghav@ddn.upes.ac.in

The intensify efficiency of packed bed solar energy storage system is accompanied by substantial increase in pressure loss, so the solar energy storage system should be optimised in such as way that there is a maximum thermal gain accompanied by minimum possible pressure loses. Pressure loses is generally the function of Reynolds no (Re), Sphericity (ψ), Void fraction (ϵ), Equivalent diameter (De). So, in this paper an attempt is being done to optimise the value of sphericity and some design is being proposed and the effect of sphericity over the volumetric heat coefficient and Pressure loses are being analysed.

161

Tribological behavior analysis of engine component material with Diesel & various Bio diesels**Sajan K Chourasia¹, Absar M Lakdawala² and Rajesh N Patel^{3*}**

1 Research Scholar, Mechanical Engineering Department, SoE, Institute of Technology, Nirma University, Gujarat - 380015, India

2 Associate Professor, Mechanical Engineering Department, SoE, Institute of Technology, Nirma University, Gujarat - 380015, India

3 Professor & Add. Director, Mechanical Engineering Department, SoE, Institute of Technology, Nirma University, Gujarat - 380015, India

*rnp@nirmauni.ac.in

Biodiesel made from vegetable oil can be reflected to be the best adaptable alternative fuel for half or fully replacement of the diesel fuel. Earlier studies on biodiesel and there blends have proven that the use of biofuels in existing engine can be a favourable characteristic for partial eradication of diesel from C.I. engines. Therefore, this study investigates the tribological impact of various biodiesels along with diesel and their optimum blend at normal room condition. Through tribological analysis conducted using a pin-on-disc tribo-meter. At the end of the tests, the coefficient of friction, friction force and wear of pins (Aluminium, Copper and Iron) were examined, apart from this weight & volume loss of the metal pins were also investigated and pin surfaces were characterized by surface microscopic analysis. Fuel constituents and fatty acid content were investigated by GC-MS and FT-IR tests for better understanding the cause of tribology. Results show that castor and rapeseed oil show the low-est weight of pin in compare to diesel, wear rate of metals with diesel shows extreme rises in wear as the sliding distance increase. The CoF & FF of pins was found to be highest with diesel followed by biodiesel and their blend in almost every case.

163

Optimization of Transesterification Process for Biodiesel Production from Waste Sunflower-Cooking-Oil**Suraj Shinde*, Aditya Burondkar, Omkar Kadam, Madhukar Tandale**

Department of Mechanical Engineering,

Dr. Babasaheb Ambedkar Technological University, Lonere 402 103

*suvrunda1914@gmail.com

Biodiesel is one of the renewable sources of energy for mainly transport sector, meeting the global energy demand simultaneously mitigating the emission effectively by reducing the green house gases. Sunflower oil is prominently used in elite hotels in India. The waste cooking oil from restaurants and hotels is not expected to be reused for cooking. In India, approximately nine million tonnes of waste cooking oil is generated per year. If the waste cooking oil (WCO) is not processed or re-used, it will unnecessarily pollute the environment. One of the options is to use this oil for biodiesel production. This paper is based on experimental study of conversion of waste cooking oil into biodiesel through transesterification process and identification of the input parameters for maximizing the yield of biodiesel. The sample of WCO for the present study was collected from nearby restaurants. Methanol was used as a reactant along with two base catalysts; KOH & NaOH separately and also as a mixture. The input parameters selected for the study are: methanol-to-oil molar ratio, catalyst type and reaction temperature. The orthogonal experimental array L9 was selected with three parameters and three levels. The optimum set of input parameters for the transesterification process is; 9:1 methanol-to-oil molar ratio, KOH as a catalyst, 60°C reaction temperature. The maximum yield of sunflower oil methyl ester was 87.2% with 2.0% catalyst concentration by weight. Since, the properties of Sunflower oil methyl ester are comparable with diesel, it is the potential candidate in near future for partial replacement of Diesel for CI engines.

164

Three dimensional investigation on energy separation in a Ranque-Hilsch vortex tube**Nilotpala Bej^{1*}, Pooja Chaubdar¹, Anish Pandey¹ and K.P. Sinhamhapatra²**¹Kalinga Institute of Industrial Technology, Bhubaneswar, 751024, INDIA²Indian Institute of Technology, Kharagpur, 721302, INDIA

*nilotpala2002@gmail.com

This paper addresses the study of energy separation associated with a Ranque-Hilsch Vortex Tube (RHVT) using three-dimensional numerical simulations. As pressure is the only available energy at the inlet, therefore, design of nozzle imparts a strong effect in temperature separation. In this context, the effects of total inlet area and nozzles number have been set as the prime objective of the problem. To achieve so, a three-dimensional geometry of the model has been incorporated to avoid modelling errors due to the hypotheses involved in solving two dimensional axisymmetric one. Subsequently, reliability on the axisymmetric models reported in open literature by other researchers in this field is another agenda of the present computational simulation.

165

Enhanced Butterfly Mating Optimization Algorithm for Real Power Loss Reduction**Dr. Kanagasabai Lenin**

Department of EEE, Prasad V. Potluri Siddhartha Institute of Technology, Kanuru, Vijayawada, Andhra Pradesh -520007.

gklenin@gmail.com

In this paper Enhanced Butterfly Mating (EBM) Optimization algorithm is proposed to solve optimal reactive power problem. Butterfly Mating Optimization algorithm is modeled based on the mating behavior of butterfly. In the projected enhanced algorithm to find the distance between *i*th butterfly and *j*th butterfly hamming distance technique has been used. By employing the Vector Displacement Variable Step Size Mechanism the step size of displacement alterations in the movement stage has been found in the enriched algorithm. Enhanced Butterfly Mating (EBM) Optimization algorithm has been tested in standard IEEE 30 bus test system and simulation results show the projected algorithm reduced the real power loss considerably.

166

Bamboo Plant Intellect Deeds Optimization Algorithm for Solving Optimal Reactive Power Problem**Kanagasabai Lenin***

Department of EEE, Prasad V. Potluri Siddhartha Institute of Technology, Kanuru, Vijayawada, Andhra Pradesh -520007, India

*gklenin@gmail.com

In this paper Bamboo Plant Intellect Deeds Optimization Algorithm (BPD) is proposed to solve optimal reactive power problem. By changing physiology, phenotype, and architecture Bamboo Plants can search their food. Normally Bamboo Plants alter its morphology, physiology, and phenotype accordingly to natural conditions. In Bamboo Plants Signal transduction will trigger the biochemical actions in the plant as response to the conditions. Bamboo Plant Intellect Deeds Optimization Algorithm (BPD) has been tested in standard IEEE 57 bus test system and simulation results show the projected algorithm reduced the real power loss considerably.

168

Performance Comparison of Evacuated U-Tube Solar Collector Integrated Parabolic Reflector with Conventional Evacuated U-Tube Solar Collector**B. Kiran Naik¹, S. Premnath² and P. Muthukumar^{1*}**¹Mechanical Engineering Department, IIT Guwahati, Guwahati, Assam-781039, India²Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu - 638 401, India

*pmkumar@iitg.ac.in; *pmkumariitg@gmail.com

In the present study, performance of the fabricated evacuated U-tube solar collector integrated parabolic reflector (EUSCIPR) and conventional evacuated U-tube solar collector (CEUSC) are analysed experimentally. With reference to humid climatic conditions, a 3D model is developed for comparing the thermal performance of EUSCIPR with a CEUSC. Developed model is val-idated

with field test data and found a good agreement among them. Heat transfer fluid (HTF) temperature difference, energy intake/heat gain and thermal efficiency of the solar collectors are investigated experimentally at various ambient temperatures and solar intensities. From the experimental investigations, it was observed that, in a sunny day, the energy losses incurred across the solar collectors was high during peak hour (1: 20 PM). From the numerical studies, it is found that within the given operating range, the thermal efficiency of the EUSCIPR is 14.1% higher than CEUSC. Further, for a given inlet condition, the contour plots for variation of HTF temperature along the U-tube of EUSCIPR and CEUSC are predicted numerically and the obtained results are discussed in detail.

169

Actuator Fault Detection and Isolation for PEM Fuel Cell Systems using Unknown Input Observers

Vikash Sinha* and Sharifuddin Mondal

Department of Mechanical Engineering, National Institute of Technology, Patna Bihar-800005, India
*vikash.me15@nitp.ac.in

An unknown input observer design problem based actuator fault detection and isolation scheme for proton exchange membrane fuel cell systems is presented. The algorithm is derived assuming that a single actuator fault occurs at any time instant. First, a number of unknown input observers are designed for proton exchange membrane fuel cell systems such that one specific unknown input observer will be sensitive to a specific actuator and then residuals are determined. Then a fault detection and isolation algorithm is formulated based on the residuals. The effectiveness of the proposed approach is shown with simulated results for proton exchange membrane fuel cell system single actuator fault scenario.

171

Analysis of Heating and Cooling Energy Demand of School Buildings

Tshewang Lhendup^{1*}, Samten Lhendup² and Hideaki Ohgaki³

¹Centre for Renewable and Sustainable Energy Development, College of Science and Technology, Royal University of Bhutan, Rinchending, Bhutan

²Jigme Namgyel Engineering College, Royal University of Bhutan, Dewathang, Bhutan

³Institute of Advanced Energy, Kyoto University, Uji, Japan

*tshewanglhendup.cst@rub.edu.bt

This paper presents a simulation study to investigate the impact of insulation on the heating and cooling energy demand of school buildings in two climate conditions of Bhutan. The average annual heating and cooling energy demand of school buildings without insulation are 19 kWh/m² and 36.5 kWh/m² respectively. By adding 100 mm layer of mineral wool between the ceiling and the roof can potentially reduce the heating energy demand by 1.3% in temperate climate and 7.2% cooling energy demand in a tropical climate. In a temperate climate, the addition of insulation in the external wall can reduce heating energy demand by 52% but it increases the cooling energy demand by 5.4 times the baseline. The net decrease in total heating and cooling energy demand is not significant. Thus, addition of insulation in the external wall in a temperate climate is not advisable unless combined

with a ventilation system. In a tropical climate, the addition of insulation in the walls result in 70% increase in the cooling energy demand.

172

Thermodynamic performance analysis of adsorption cooling and resorption heating system using ammoniated halide salts

Rakesh Sharma¹, K. Sarath Babu² and E. Anil Kumar^{2*}

¹Indian Institute of Technology Indore, Indore 453552, INDIA

²Indian Institute of Technology Tirupati, Tirupati 517506, INDIA

*anil@iittp.ac.in

In the present work, a combination of gas–solid sorption system, namely; Adsorption Cooling and Resorption Heating System (ACRHS) in which cooling and heating effects are observed by adsorption and resorption processes respectively, is thermodynamically analyzed using different halide salts MnCl₂, FeCl₂, CaCl₂ and SrCl₂. The adsorption heat, which is lost in basic adsorption or resorption cooling system, is transformed into useful high temperature thermal energy. The overall coefficient of performance of the ACRHS is improved due to the production of heating effect in addition to cooling effect. This dual effect of heating and cooling is produced by a single heat input which is realized because of recovery of heat between two salt beds (high and medium temperature salt). MnCl₂ is having low desorption enthalpy and high adsorption capacity due to which the COP is 34% higher than that for FeCl₂. The maximum value of COP of ACRHS is found to be 0.72.

173

Market Structures and Power Trade in South Asia

Priyanshi Chauhan

Research Scholar Centre for South Asian Studies

Jawaharlal Nehru University, Delhi

South Asian region is experiencing very high GDP growth rates along with the increasing population, urbanisation, standards of living causing an increase in energy demand. While the demand for energy has increased, the indigenous available sources of energy and the imports are not sufficient to meet the burgeoning demand. Thus, there exists a gap between the supply and demand for energy which puts constraints on the economic growth of the region. Power trade in South Asia can address this gap and alleviate the concerns regarding sustainability of economic growth and development in the South Asian region by using the complementarities that exist in available resources of energy and peak energy demand in individual countries. Over the years, power trade between countries in the region have increased but is limited and exists only at the bilateral level. One of the challenges to the power trade in South Asia is the limited and incomplete nature of domestic power sector reforms, particularly the existence of state ownership. The objective of this paper is to study the existing arrangements for power trade in South Asia and analyse the role of market structures in facilitating power trade in the region. For this, an examination of key trends in the power sector and cross border electricity trade in South Asian countries of India, Nepal, Bangladesh and Bhutan has been undertaken. This has been done against the conceptual understanding of the existence of natural monopoly in the power sector, and the cost benefit analysis of the restructuring and introduction of competition. Further, the status of market structures in the selected countries has been examined, and its impact on the existing cross border electricity trade analysed.

176

Correlating partial shading and operating conditions to the performance of PV panels**S. Gairola, M.K. Sharma, J.Bhattacharya***

Department of Mechanical Engineering Indian Institute of Technology, Kanpur

*jishnu@iitk.ac.in

Harvesting solar energy as a renewable source to meet the expanding energy demand is essential for the sustainable growth and a greener planet. The performance of the photovoltaic panels is affected by the factors such as partial shading, elevated temperature, mismatch between the cell parameters etc. which contribute to the loss in an inter-correlated manner. In the current study, we isolate the contribution from each factor through experiments. The partial shading is configured through distributed paper chips in different patterns keeping the overall shaded area constant. The isolation of shading loss from the total loss allows us to find out the total contribution from the mismatch and temperature factors. In further set of experiments, we isolate these two factors as well. We find that the major contribution comes from the shading loss. We also observe that not only the fraction of the partial shading but also the shading pattern has crucial bearing on the panel performance. For equal fraction of the partial shading, the more distributed the shade, the less the loss. The next major contributor is the temperature loss for which we find out empirical formulae to predict the performance under different operating conditions. The overall effort is aimed at estimating the operational efficiency of the PV panels under soiled or partially shaded conditions.

177

Engineering of O₂ Electrodes by Surface Modification for Corrosion Resistance in Zinc-Air Batteries**Imran Karajagi², K. Ramya^{1*}, P.C.Ghosh³, A. Sarkar⁴, N.Rajalakshmi¹**¹Centre for Fuel Cell Technology (CFCT), International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), 2nd Floor, IIT-M Research Park, Phase-1, 6, Kanagam Road, Taramani, Chennai - 600113, India.²Centre for Research in Nanotechnology and Science (CRNTS), Indian Institute of Technology Bombay, Powai, Mumbai – 400076, India.³Department of Energy Science and Engineering, Indian Institute of Technology Bombay, Powai, Mumbai – 400076, India.⁴Department of Chemical Engineering, Indian Institute of Technology Bombay, Powai, Mumbai – 400076, India.

*ramya@arci.res.in

The development of stable, high performance and cost effective oxygen electrode is necessary in metal-air battery for oxygen reduction and oxygen evolution reaction. Carbon based air electrodes are conventionally used in metal-air batteries due its high specific surface area, porosity and high electrical conductivity. However, the highly oxidative environment of metal-air batteries during charging corrodes the carbon air electrodes which lead to poor cyclic stability. The current study develops a hybrid air electrode with a nickel inter-layer between carbon and electrocatalyst. This approach protects the carbon from corrosion and also provides low resistant pathway for electron

conduction by metallic nickel interlayer and improves the electrocatalytic activity of silver electrocatalyst deposited on metal nickel layer. The electroless deposition of nickel interlayer was optimized by deposition time. The electrochemical performances of the electrodes were investigated to study the stability during cycling. Charge discharge cycling shows the excellent stability over 500 cycles for nickel interlayer deposited for 3 hours. These results prove that the Ni interlayer circumvents the carbon corrosion at higher oxidative potentials during oxygen evolution reaction. This work demonstrates the potential of Ni-modified electrode for use as high performance, stable air cathode in zinc-air battery.

178	Energy Farming - A Green Solution for Indian Cement Industry
------------	---

Kapil Kukreja^{1*}, Manoj Kumar Soni², B.N Mohapatra and Ashutosh Saxena

¹ National Council for Cement and Building Materials (NCB), Ballabgarh

² Birla Institute of Technology and Science, Pilani

*kkancb@gmail.com

Cement sector in India is playing an important role in overall development and infrastructure. Coal is the main fuel for the manufacture of cement in India, given the high cost and inadequate availability of oil and gas. Another fuel required to operate the cement plant is Diesel. It is required for drilling machine (In mines for blasting), for earth moving machines and in clinker production process for Diesel generator to generate emergency power, Kiln Initial Light up, various material handling vehicle etc. Lot of Research is being done to reduce coal consumption in cement plant by replacing the coal through alternative fuels like shredded tyre chips, plastic waste, Refused Derived Fuel (RDF) from MSW, Agro waste etc. Research for reducing the energy consumption is also in advance stage where Bureau of Energy Efficiency (BEE) has made the scheme for Mandatory Energy audit of cement plants. Cement industry still has not focused on saving of diesel consumption as the consumption of Diesel is less as compared to main fuel (Coal). However, it is well relevant to specify here the rise in diesel cost in India in last five years are alarming for the cement industry. This paper highlights the saving in diesel cost by introducing Energy Farming (EF) concept in place of green belt area which is statutory requirement for obtaining Environmental Clearance for cement plant and mines area.

179	Thermal Performance of three side's solar air heater having roughness elements as a combination of multiple-v and transverse wire on the absorber plate
------------	--

Bhuvnesh Sharma, Dhananjay Kumar, Karteek Reddy*, Laljee Prasad and M.K Paswan

National Institute of Technology, Jamshedpur Jharkhand 831014, India Incs@springer.com

Artificial roughness has been found to enhance the thermal performance from collector to the air in a solar air heater duct. This paper presents the results of an experimental investigation on thermal performance of three sides solar air heater roughened with combination of multiple-v and transverse wire. The range of variation of system and operating parameters is investigated within the limits of relative roughness pitch of 10-25, relative roughness height of 0.018-0.042, angle of attack of 30°–75° at varying flow Reynolds number in the range of 3,000-12,000 for fixed value of relative roughness width of 6. The augmentation in fluid temperature flowing under three sides roughened

duct is found to be 36.57% more than one side roughened duct. The maximum thermal efficiency is obtained at relative roughness pitch of 10 and relative roughness height of 0.042, and angle of attack of 60°. The augmentation in thermal efficiency of three sides over those of one side roughened duct is found to be 46-57 % for varying P/e , 38-50 % for varying e/D and 40-46% for varying angle of attack.

180

Energetic and Exergetic Performance Comparison of a Hybrid Solar Kalina Cycle at Solar and Solar Storage Mode of Operations

P. Bhuyan, P. Borah, T.K. Gogoi*

Department of Mechanical Engineering, Tezpur University, Tezpur – 784028, India

*tapan_g@tezu.ernet.in

In this study, the energy and exergy analysis are performed to compare the performance of a hybrid solar Kalina cycle (KC) in the solar storage (SS) and solar mode of operations. The solar radiation was calculated for the geographical location of Jodhpur, Rajasthan, India at 7 am and 2 pm on 21st day of February to represent the above two modes of operation. Due to higher global radiation, the heat gain, the collector and the exergy efficiency of the parabolic trough collector (PTC) was found to be more during the SS mode of operation. Similarly, the KC also performed better in terms of net power output and exergy efficiency during the SS mode. Further, in the SS mode, water heating also could be obtained additionally. Highest irreversibility occurred in the PTC. Compared to the solar mode, the PTC irreversibility was however more in the SS mode. The water heater also contributed a significant amount of irreversibility. Among the KC components, the condenser irreversibility was the highest followed by the vapour turbine (VT) and the regenerator, both during the SS and solar mode of operations. The number of collectors in a single row and the rows of collector elements, the flow rate of the heat transfer fluid (HTF) and its temperature at PTC inlet finally decides the heat source temperature at inlet of the vapour generator, the mass flow rates and the net power output of the KC.

181

Enhanced Reversible Hydrogen Storage in Palladium Hollow Spheres

Flamina Amaladasse¹, Anshul Gupta¹, Suboohi Shervani¹, Sri Sivakumar², Kantesh Balani¹ and Anandh Subramaniam^{1*}

¹Department of Materials Science and Engineering, Indian Institute of Technology, Kanpur-208016, India.

²Department of Chemical Engineering, Indian Institute of Technology, Kanpur -208016, India.

*anandh@iitk.ac.in

Palladium has long been used as a hydrogen sponge because of its ability to store hydrogen under ambient conditions (room temperature & 1 atm pressure). However, it suffers from low storage capacity. The current investigation pertains to the enhancement in the reversible hydrogen storage capacity of Pd by using hollow sphere geometry. Additional storage is achieved in molecular form; thus utilizing a recently developed multi-mode storage strategy. Hollow spheres, which can be viewed as nanocontainers, have been synthesised using a chemical reduction method (outer diameter of ~300 nm and shell thickness ~30 nm). Pressure-composition-isotherms have been used to

characterize the hydrogen storage capacity and to establish the reversibility of the process. A 70 % enhancement in the reversible storage capacity (25°C and 140 bar) is observed in the case of hollow spheres as compared to that for Pd. The outer and inner surfaces of the hollow sphere play contrasting catalytic roles in the absorption and desorption process.

182

Effects of Inlet Parameters on Flame Propagation in Microscale Tubes.

Raksha P Mani¹, B. Aravind^{2*} and Sudarshan Kumar²

¹ Department of Aeronautical and Automobile Engineering, Manipal Institute of Technology, Manipal, Karnataka.

² Department of Aerospace Engineering, Indian Institute of Technology, Powai, Maharashtra.

*aravindpillai69@gmail.com

Abstract. In this work, unsteady numerical simulations with chemical kinetic mechanism for premixed H₂/air mixture has been performed in microscale tubes. The fundamental parameters affecting flame propagation in micro-tubes are studied. The geometrical parameters of the tube are kept constant and the in-let parameters have been varied. Notable variations in the flame propagation ve-locities, and flame shapes were observed with the increase in inlet velocity. By changing the equivalence ratio from lean to rich range, for different wall heat transfer coefficients the parameters have seen to peak at an equivalence ratio of 1 as the intensity of gas phase reaction decreases as the mixture becomes richer. At higher inlet temperatures, the flame propagation velocity was observed to increase because of the increased collision of fuel air molecules.

183

Design and Analysis of Hybrid Vertical Axis Giromill Wind Turbine

Shivaji Gawali¹, Parikshit Jamdade^{1*}, Shrinivas Jamdade², Vinod Hiwase¹, Akash Naokar¹, Shubham Modgi¹, Omkar Patwardhan¹, and Amol Zope¹

¹PVGs College of Engineering and Technology, Pune, Maharashtra, India

²Nowrosjee Wadia College, Pune, Maharashtra, India

*parikshit_jamdade@yahoo.co.in

The current study presents the design and construction of hybrid vertical axis giromill wind turbine. Hybrid vertical axis giromill wind turbine is developed to enhance the low wind speed performance of conventional savonius wind turbine. Normally wind speed decreases from inlet to outlet. This study shows that this decrease in wind speed is lower in hybrid vertical axis giromill wind turbine as compare to the conventional savonius wind turbine. Due to this there is a 60% increase in wind speed that can be used to generate more power. This is in tandem with the theoretical considerations of Betz limit. The pressure change on the blade is nearly 100% for 5m/s while it goes on decreasing with increase in wind speed. Dynamic pressure goes on decreasing from 3.975e+002 Pa to 8.876e-003 Pa which indicates that the more kinetic energy is absorbed by the hybrid vertical axis giromill wind turbine for generating power as compared the savonius wind turbine. The total relative pressure decreases as from front blade to the back blade with a change in value of about 397.75 Pa.

186

Time Response and Stability Analyses of Integrated Renewable Energy System**Chandra Prakash Varma^{1*}, Yaduvir Singh^{2**}**¹Dept. of Electronics Engg., Dr. Ambedkar Institute of Technology for Handicapped, Kanpur, India²Dept. of Electrical Engg., Harcourt Butler Technical University Kanpur, India

*cpv@aith.ac.in, **dryaduvirsingh@gmail.com

Integrated Renewable Energy System (IRES) technology is the need of time due to fast depleting fossil fuels and advent of new and new sustainable energy resources. An IRES may consist of sources like solar, wind, Micro Hydro Power (MHP), biomass, biogas etc. Two basic blocks of integrated renewable energy system are capacitor energy storage system (CES) and automatic generation control (AGC). In this paper, capacitor energy storage system (CES) and automatic generation control (AGC) have been designed and simulated for their time response and stability analyses. The mathematical modeling, simulation results of CES and AGC have been presented. Different unique reaction having lesser plentifulness (both undershoot and overshoot) and lesser settling time under flaw and consequent clearing condition. In IRES, fundamental controlled AGC loop is appropriately tuned. Time response analysis shows optimistic results and proper tuning of parameters of CES and AGC blocks have finally resulted in the stable design of IRES.

187

Identification of Suitable Integrated Renewable Energy System for states of Uttar Pradesh and Uttarakhand and Time Response Analyses of its Power System Stabilizer**Chandra Prakash Varma¹, Yaduvir Singh²**¹Dept. of Electronics Engg., Dr. Ambedkar Institute of Technology for Handicapped, Kanpur, India

Dept. of Electrical Engg., Harcourt Butler Technical University, Kanpur, India

cpv@aith.ac.in, dryaduvirsingh@gmail.com

It is necessary to use nonconventional energy systems for the upliftment of GDP of India. In view of various electricity problems and electricity installation of Uttar Pradesh and Uttarakhand states, a lot of work is carried out with conventional and nonconventional energy systems. The various sectors i.e. state, central and private are being utilized for electricity installation by means of coal, gas, diesel, nuclear, small hydro (renewable) and renewable energy systems. In Uttar Pradesh, UPNEDA is providing the solution of electricity problems whereas in Uttarakhand state, UREDA is solving the electricity problems by solar systems. Suryamitra scheme is also solving the electricity issues in India. Modeling, cost function and statistical analysis of integrated renewable energy system have been done with solar, wind and battery. A Case study of Jamny Ven village Barwani Madhya Pradesh, India has been considered wherein solar, wind and battery is found suitable. Integrated Renewable Energy Source as solar and wind with battery is proposed. The time response of PSS for various bounded inputs is bounded output. Thus, PSS exhibits BIBO stability.

192

Variations in MACE to Study Silicon Nanowires Synthesis on Silicon and Porous Silicon Substrate**Mihir Kumar Sahoo**^{1[0000-0003-1397-0703]*} and **Paresh G. Kale**^{2[0000-0001-6311-2366]**}

Department of Electrical Engineering, NIT Rourkela, 769008, Odisha, India

*kumarmihir1992@gmail.com, **pareshkale@nitrkl.ac.in

Metal-assisted chemical etching (MACE) of silicon (Si) or porous Si (PSi) substrate fabricates silicon nanowires (SiNWs) using an electrolyte com-posed of hydrofluoric acid (HF) and hydrogen peroxide (H₂O₂), and metal salt (e.g., AgNO₃) at room temperature. The structure and morphology of SiNWs are characterized by high-resolution transmission electron microscopy (HRTEM), field emission scanning electron microscopy (FESEM), and Raman spectroscopy. The cross-sectional view of FESEM images confirms the for-mation of SiNWs and the HRTEM image shows the crystallinity of SiNWs. The Raman line broadening and peak shift are due to quantum confinement ef-fect, stress, and amorphous content (~5%) in SiNWs. The tensile strain remains less than 0.25%, and the crystallinity volume fraction of more than 95% pro-vides a range of MACE parameter variation to fabricate the SiNWs according to various device applications. Contact angle measurement of the surface of both the substrates on which SiNWs are fabricated is superhydrophobic in na-ture. Current-voltage characteristic of SiNWs is non-linear (i.e., diode-like be-havior) due to Schottky barrier contacts at the metal-Si junction.

193

Assessment of Different Multiclass SVM Strategies for Fault Classification in a PV System**Rahul Kumar Mandal*** and **Paresh G. Kale**

Department of Electrical Engineering, NIT Rourkela, 769008, Odisha, India

*rahulvishnu2310@gmail.com,

Fault detection and diagnosis is an imperative choice for the long life of a PV system. The conventional protective devices fail to detect possible faults, owing to the non-linear nature of the voltage-current characteristics of the PV system impelling the need for a better technique. A novel approach to classify PV faults, making decision boundaries using SVM, propelled by dimension reduction using PCA is demonstrated for classifying different fault classes. Faults considered for classification are short circuit fault in any module, inverse bypass diode fault, shunted bypass diode fault, and shadowing effect in a module. SVMs are binary classifiers and involve meticulous effort for extending the theory to more than two classes. The paper highlights the efficiency and run-time complexities of the various multiclass SVM techniques like One vs. One, One vs. All, Decision Directed Acyclic Graph, and Adaptive Directed Acyclic Graph. Methods are compared for the results different ‘training: testing data samples’ (60:40, 70:30, 80:20) using synthetic PV data points from PVLIB toolbox.

194

Feasibility Study of Packed Bed Liquid Desiccant Dehumidification and Regenerative Evaporative Cooling for Ships

Pranav Kumar Iyer, Indian Coast Guard, c/o ICGS Kamorta, Nancowry Group of Islands, A&N, India, pranavgmfl@gmail.com

Dr. A. Ganguly, Department of Mechanical Engineering, Indian Institute of Engineering Science and Technology, Shibpur, India aritra78@gmail.com

The present article proposes an alternate air conditioning system in ships to mitigate the disadvantages of Vapor Compression System (VCS). The proposal includes a packed bed liquid desiccant based de humidification, followed by regenerative evaporative cooling. Regeneration of desiccant solution is carried out by using waste heat of hot water from the ship's Diesel Alternators, while cooling of regenerated desiccant is done by means of sea water. MATLAB software was used to carry out thermal modelling of the system based upon design data for a 267 tons displacement class of ship. Data from the thermal modelling shows that achieving the design enthalpy of 43.51kJ/kg is feasible provided the control parameters are operated within a particular range summarized at the end of the paper. These parameters include the mass flow rates of outdoor air, desiccant and return air in addition to temperatures of hot water and desiccant solution. The effects of the parameters on system performance have been validated from data available in literature. The suggested methodology for obtaining the operating range of parameters can be used for any class of ships and for similar de humidification / evaporative cooling systems. Results also indicate a reduction of 20% of power consumption as compared to VCS, in addition to significant reduction in maintenance costs due to usage of only pumps instead of a refrigerant – compressor based system.

195

A study on efficient use of plastic waste to generate energy :An approach to decrease the harmful effect of micro-plastic on human endocrine system with a view to producing eco-friendly plastic

Rafiur Rahman Khan¹, Tarlin islam¹

¹Bangladesh University Of Engineering and Technology(BUET), Dhaka, Bangladesh

²Medical College for Women and Hospital, .Dhaka, Bangladesh

Going green and to use renewable energy is the prime demand of the environment. In this paper we will discuss the way to get green environment by utilizing the waste plastic. The use of plastic is essential today, so it is not the matter of concern today whether it can be used or not, the main matter of concern is the efficient utilization of plastic wastes and to mitigate the harmful effects of micro-plastics which are gener-ated in frequent basis . For fulfilling this objective plastic waste should be converted into resources e.g. it can be used as fuel, landfill, in energy generation & for making road. Small business can be started to buy this plastic wastes to save the environment. Hence according to the environmental desire, by following the above discussed things with proper waste management we may hope about a clean and green environment. Plastics have now become indispensable materials in the modern world and application in the industrial field is continually increasing. This paper focuses on the properties of plastics and micro plastics were analyzed and preventive solutions were taken in order to improve the plastic production techniques .Also methods of efficient handling of the by-product of plastics and the micro-plastics were provided in order to generate energy and to increase the use of environment-friendly plastic.

196

Investigation of energy policies and energy market in Nepal**Nawaraj. Sanjel^{1*} and Bivek. Baral¹**¹ Department of Mechanical Engineering, Kathmandu University, Nepal

*sanjelnawaraj@ku.edu.np

The article examines the energy related policies of Nepal and provisions to promote renewable energy in Nepal and its regulatory framework. It analyses the pertinent energy policies related to energy generation and distribution. The article inspects the options of renewable energy technologies within the background of long-lasting power shortages that Nepal has been facing. Currently the article analyses the hydropower development policies, electricity act and the scope of energy policy 2006. The study has been conducted with-in the context of renewable energy sector of Nepal and its effects upon development of the renewable energy. The almost linear electricity generation of NEA (including IPPs) against steep gradient of peak power demand has ultimately increased the power purchase from India. The article has examined the difference in slope of peak demand against the total generation which is found to be 47.10. This difference in slope has been adjusted by increasing power purchase with slope of 358.77. The study has also analyzed barriers for rural electrification. The study concludes upon primary information collected from interviews with prominent stakeholders, policy documents and identifies technical, financial and geographical as three main types of barriers that have interfered with a more successful expansion of renewable energy sector in Nepal.

198

Extinction of non-premixed 'volatiles' flame: Experiments on single biomass particles and connection to counter-current flame propagation in packed beds**Mani Kalyani Ambatipudi*, Jaganathan VM, and Varunkumar S**

Department of Mechanical Engineering, IIT Madras

*manikalyani24@gmail.com

In this paper, a possible connection between the extinction of non-premixed 'volatiles' flame and 'gasification to combustion transition' in biomass packed beds is explored. It is known from earlier studies with air as an oxidizer, that the 'gasification to combustion transition' in packed beds occurs in the superficial velocity range of 16 -18 cm/s. Flow conditions at this transition point are shown to correspond to a strain rate of about 150 s⁻¹. Single particle experiments show that the classical envelope diffusion flame transitions into a wake flame at around the same strain rate value. Simultaneous volatile-char oxidation observed in packed beds as well as in single particle wake flames, post-transition, is consistent with this observation. The decrease in reaction layer thickness from 2-3 particles in gasification regime to 1 particle in combustion regime in packed beds, also supports this hypothesis.

199

Carbon Nanofiber Aggregate Sensors for Sustaining Resilience of Civil Infrastructures to Multi-Hazards**Karthiga Shenbagam N¹, Mohanraj A¹**¹Bannari Amman Institute of Technology, Erode, Tamilnadu, India

Karthi47@gmail.com, mohanraja@bitsathy.ac.in

Natural disasters (earthquakes, hurricanes, tornadoes, and floods) or man-made disasters or accidents (missile/aircraft impacts, fires, and explosions) lead to substantial damage on critical infrastructures and communities and have social, economic, and environmental consequences. As the safety of civil infrastructures is critically important, effective structural health monitoring (SHM) systems of infrastructures should be developed to avoid and mitigate the risks caused by various types of hazards. Carbon Nanofiber Aggregates (CNFAs) developed at the University of Houston are piezoelectric aggregates that can respond uniquely to different multi-hazards. This unique response makes this a sensor capable of being used in the Structural Health Monitoring (SHM) of civil infrastructures in each of the multi-hazards. This paper explains how CNFAs can be used for multi-hazard monitoring and discusses the ultra-low noise, high sensitivity of CNFA sensor electrical interfaces, radiation-tolerant wired and wireless communication capabilities of the CNFA sensor which leads to the very possible development of the wireless CNFAs' real-time SHM system for sustaining resilience of civil infrastructures to multi-hazards.

200

Performance Analysis of Double Glass Water Based Photovoltaic/Thermal System**Ajay Sharma, Vaishak S and Purnanand V Bhale***

Renewable and Sustainable Energy Lab, S. V. National Institute of Technology, 395007 Surat, India

*pvbhale@med.svnit.ac.in

In order to improve the photovoltaic (PV) system efficiency and to get a high yield per unit area, much research has been done in the field of hybrid photovoltaic thermal (PV/T) system. This system co-generates both heat and electricity with better yield compare to independent photovoltaic and solar thermal system. The present study experimentally analyzes the performance of an in-house developed double glass water based PV/T system under the climatic conditions of Surat, India (21.1702° N, 72.8311° E). Under the tested condition, the average value of electrical efficiency of the system was observed to be 13.8% while thermal efficiency was found to be 66%. Besides, it was observed that the present system was capable to support hot water requirement of the domestic sector with an average overall efficiency of 80%.

201

Thermal Performance Enhancement of Bio-PCM used for Latent Heat Storage using Different Nano Particles**Akhil K V*, Dnyandip K Bhamare, Varun Joshi and Manish K Rathod**

Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, 395007 India

*akhilkv04@gmail.com

Latent heat storage is a promising method to effectively utilize solar energy that is being wasted. Phase change materials are commonly used in this aspect. Bio-PCM is taken for the study as it is comparatively new and has excellent properties for thermochemical energy storage. Coconut oil is taken for study as it is cheap and easily available. The nanoparticles used are aluminum oxide (Al₂O₃), Copper oxide (CuO) and Zinc oxide (ZnO). A cylindrical thermal energy system is used for the study of the melting of nano PCM. Enthalpy- porosity method is used for developing a numerical model for the PCM. A numerical model is developed for the melting and is validated with the experimental work done by Ebadi et al.[1]. The development of the solid-liquid interface and the variation on melting fraction is studied. It has been found that the maximum performance enhancement was obtained at 0.5 volume concentration of nanoparticles. Moreover, nano PCM having alumina nanoparticles are found to be having better thermal performance than other nanoparticles.

202

Modeling Polarization Losses in HTPEM Fuel Cells**Vamsi Ambala*, Anusree Unnikrishnan, N. Rajalakshmi and Vinod M. Janardhanan**

Department of Chemical Engineering, Indian Institute of Technology Hyderabad, Sangareddy-502 285

*vj@iith.ac.in

A numerical model for simulating the distributed charge transfer in HTPEM is presented. The electrodes are discretized along its thickness and the model resolves the species composition, mixture density and the ionic and electronic potential. The rate of hydrogen oxidation and oxygen reduction reactions is derived based on rate limiting assumptions applied to a set of elementary single electron transfer reactions. Subject to the rate determining step chosen the derivation results either in Butler-Volmer type or non-Butler-Volmer type rate expressions. The form of exchange current density is a result of derivation and depends on the concentration of reactants and products. The order of the rate depends on the symmetry factor for charge transfer reaction. The model is validated by reproducing experimentally measured cell polarization data and activation losses.

204

Effect of Diesel Injection Timings on the Nature of Cyclic Combustion Variations in a RCCI Engine**Ajay Singh, Rakesh Kumar Maurya* and Mohit Raj Saxena**

Advanced Engine and Fuel Research Laboratory, Department of Mechanical Engineering, Indian Institute of Technology, Ropar, Rupnagar 140001, India

*rakesh.maurya@iitrpr.ac.in

In this study, the combustion stability of RCCI engine is investigated to determine the underlying non-linear dynamic characteristics. The 0-1 test is used for estimation of dynamic characteristics and the normalized maximum pressure rise rate (PRRmax) time series of 1000 consecutive engine cycles. Start of injection (SOI) timing of diesel is used as a control parameter to investigate the effect of system parameters on the combustion dynamics. Two low reactivity fuels (gasoline and methanol) are used to achieve the RCCI combustion. The cyclic variations in combustion need to be controlled for stable engine operation. The experiments are conducted on a modified single-cylinder CI-engine equipped with a separate port fuel injector to operate the engine in dual fuel mode. Measured in-cylinder pressure is used for analyzing the combustion characteristics. For entire range of diesel SOI timings, the chaotic nature of the RCCI combustion is revealed by the 0-1 test. For too retarded and too advanced injection timing, the existence of a strong chaotic behavior signifies a more complex combustion system i.e. a high sensitivity towards the small changes in initial condition and more unrepeatable combustion characteristics.

205

Investigating the impact of energy use on carbon emissions: Evidence from a non-parametric panel data approach**Barsha Nibedita* and Mohd Irfan**

Department of Management Studies, Indian Institute of Technology (ISM), Dhanbad, Jharkhand, India

*barsha_nibedita@yahoo.com

Existing evidence for the role of energy consumption as a significant determinant of carbon emissions is very well studied. However, there are only a handful of studies in the South Asian context which are specific to individual country data and use of parametric models. Thus, the impact of energy use on carbon emissions is investigated in this study by using a non-parametric panel data approach for five South Asian countries. The non-parametric approach discovers the true relationship from the data itself rather than having any pre-defined functional form. The data in this study was compiled for five South Asian countries- India, Pakistan, Bangladesh, Nepal, and Sri Lanka using the World Development Indicators database. The study period in this study is 1978 to 2011. The estimated impact of energy consumption on carbon emissions is found to be linear and positive in nature. More specifically, there is a monotonically increasing impact of energy use on carbon emissions. However, the estimated impact of income is found to be nonlinear in nature and it shows an N-shaped type relationship. The study also investigates the impact of some other contributing factors such as trade and population density. The results indicate that in the initial stages of globalization, more openness in trade has no significant impact but in the later stages there is a positive impact. However, there is no empirical evidence that population density is a determining factor for carbon emissions.

206	Studies on the Use of Thorium in PWR
------------	---

Devesh Raj*, Umasankari Kannan

Reactor Physics Design Division, BARC, Homi Bhabha National Institute, Mumbai

*draj@barc.gov.in

A study was taken up to assess the use of thorium in PWR type of lattice. The case study was done for the 17x17 square lattice fuel assembly (FA) of Westinghouse design used in modern PWRs namely AP1000 and EPR. This work describe some theoretical results obtained by loading thorium in oxide form as main fertile with either LEU or PWR grade Plutonium as fissile seed. The fuel assembly of PWR, i.e. 17x17 lattice with 4.9% enriched UO₂ fuel is taken as reference Thorium has prominent position in fuel cycle envisaged for Gen-IV reactors owing to its promises to contain production of transuranic and minor actinides and introducing intrinsic anti proliferation feature owing to inevitable production of U²³². Another aspect of Thorium loading which is worth mentioning is the possibility of burning of Plutonium and Uranium without further producing Minor Actinides (MA) and Transuranic (TRU). Properties of Thoria, such as its extraordinary stability against corrosion and high melting points being additional advantages, Thorium loading has been studied in considerable details in functional and hypothetical nuclear reactors including in PWRs. PWRs being the most widely installed power reactor system makes it the most desirable target for the early deployment of thorium pending Gen-IV systems are developed and become a common occurrence.

208	Co-axial Thermal Probe for High Frequency Periodic Response in an IC Engine Test Rig
------------	---

Anil Kumar Rout*, Santosh Kumar Hotta, Niranjan Sahoo, Pankaj Kalita and Vinayak Kulkarni

Indian Institute of Technology Guwahati, India

*anil.rout@iitg.ac.in

Coaxial Surface Junction Thermocouples (CSJTs) are efficient thermal probes, mostly used for capturing transient response characteristics in case of unsteady flows. For the present study, a K-type (Chromel-Alumel) CSJT thermal probe has been fabricated in-house and its response characteristics have been tested in an IC engine based experiment. The probe is mounted at the exhaust of a variable compression research engine running in petrol mode at compression ratio 10:1. The transient temperature is recorded for 6s. After post processing of the signal, cyclic repeatability of the engine cycles are observed. From the recorded temperature history, time taken by the engine for completion of one complete cycle is calculated for two different RPMs (1500, 1700) and compared with the theoretical cycle time calculated analytically from the recorded RPM by engine sensor. Appreciable matching between the cycle times is observed. Therefore, the fabricated CSJT is quite fast in capturing the transient phenomena and can be used as a temperature sensor for capturing transient phenomena in IC Engines. The application can be extended to capture other transient phenomena in case of unsteady flows.

209

Effect of Injection Pressure on the Performance Characteristics of Double Cylinder 4-Stroke CI Engine using Neem Bio-diesel.**Dr. Sushant S. Satputaley* , Iheteshamhusain Jafri ,Gauravkumar Bangare and Rahul P. Kavishwar**

St. Vincent Pallotti College of Engineering & Technology, Nagpur, India

*satputaley@gmail.com

In the recent past, due to depletion of fossil fuels, crude oil prices have been raised drastically due to which the researchers are urged to find suitable bio-fuels which might supplement the conventional fuels used in present days. Bio-diesels is one of several alternative fuels designed to enhance the utility of petroleum, durability and neatness of diesel engines. To satisfy this difficult and ruinous situation, Neem can go about as an ecological amicable elective feed-stock for bio-diesel production. This paper represents the effect of Neem bio-diesel and its blending with pure mineral diesel at different injection pressure on diesel engine performance to evaluate break specific fuel consumption, exhaust gas temperature and thermal efficiency. A four stroke double cylinder compression ignition engine performance parameters were measured. The experimental research is carried out using different bio-diesel blends such as B20, B40 and B60 at different injection pressure 220, 240 and 260 bar. Based on the experimental research it can be stated that as the injection pressure increases, the brake thermal efficiency rises and specific fuel consumption reduces. It is observed that, B40 (40% Neem bio-diesel + 60% diesel) has most suitable performance characteristics. By comparing the performance at injection pressure 220, 240 and 260 bar it is observed that Maximum BTHE is obtained at 260 bar injection pressure with an increase of 8.4% at full load condition while relatively lower specific fuel consumption as compared to all the blends of bio- diesel and pure diesel among different injection pressure.

210

Experimental study of a helical coil receiver using Fresnel lens**Sumit Sharma and Sandip K. Saha***

Indian Institute of Technology, Bombay Maharashtra 400076, India

*sandip.saha@iitb.ac.in

Helical coil cavity receivers have been the object of interest in the past decade for concentrated solar power systems. Fresnel lens is utilized in this study instead of commonly used parabolic dish concentrator owing to its higher optical efficiency and ease of integrating it with the receiver for concentrating the solar radiation at the aperture of the upward facing open cavity helical receiver. Experimental study is carried out for studying the performance analysis of the helical receiver. The experiments are carried out with compressed air as heat transfer fluid for around 2.5 hours about solar noon in Bangalore, India (12.9716° N, 77.5946° E). The variation of efficiency of the receiver during the course of the experiment is studied for three flow rates of 100, 125, and 150 L/min. The maximum air outlet temperature obtained is 164 °C for 100 L/min at 44% efficiency and 140 °C for 150 L/min at 53% efficiency. The effect of direction of flow of heat transfer fluid is also studied, and it is found that higher efficiencies are achieved when the flow is from top to bottom of the receiver. The performance is evaluated based on efficiency and loss coefficient from the receiver.

211

Substrate-assisted electrosynthesis of patterned lamellar type indium selenide (InSe) layer for photovoltaic application**A. B. Bhaleraoa***, **S. B. Jambure b**, **R. N. Bulakhec**, **S. S. Kahandala**, **S. D. Jagtapd**, **A. G. Banpurkarb**, **A. W. M. H. Ansaria**, **Insik Ine**, **C. D. Lokhandef***^aK. K. Wagh Institute of Engineering Education & Research, Amrutdham, Nasik, 422003, India. anuradhapawar@gmail.com^bDepartment of Physics, Savitribai Phule Pune University, Pune, 411007, India.^cDepartment of Polymer Science and Engineering, Korea National University of Transportation Chungju 380-702, South Korea.^dDepartment of Instrumentation Science, Savitribai Phule Pune University, Pune, 411007, India.^eDepartment of IT Convergence (Brain Korea PLUS 21), Korea National University of Transportation, Chungju 380-702, South Korea

in1@ut.ac.kr

^fD. Y. Patil University, Kasaba Bawada, Kolhapur, 416 006, India.

l_chandrakant@yahoo.co.in

Indium selenide (InSe) thin films are synthesized by electrodeposition technique over diagonally scratched stainless steel substrates in potentiostatic mode. Growth kinetics of film studied to optimize deposition parameters. Suitability of thin film for photoelectrochemical cell (PEC) has been done with various characterization techniques. PEC study of thin film is performed by using current-voltage characteristics. The crystalline, lamellar type stoichiometric indium selenide thin film indicates good photoresponse with n-type conductivity. Work demonstrates a novel approach for obtaining cost-effective, patterned, lamellar type and photosensitive indium selenide thin film.

212

Hydrothermal Carbonization of Sewage Sludge: A Short Review**Milan Malhotra¹ and Anurag Garg^{1*}**¹Environment Science and Engineering Department, IIT Bombay, Powai, Maharashtra, India.

*a.garg@iitb.ac.in

Sludge biomass from wastewater treatment plants can be a potential source of energy and various valuable macromolecules. Anaerobic digestion (AD) is usually used for sludge treatment. However, it suffers several drawbacks such as high retention time, large reactor volume and inefficient solids reduction. Hydrothermal carbonization (HTC) which is performed at temperature of 150- 300°C and self-pressure, can be a viable alternative to conventional AD treatment. HTC process can enhance dewatering properties of sludge as well as results in the production of hydrochar and nutrient-rich process wastewater. Generally, majority of carbon is distributed into char, and process wastewater after HTC while a small fraction remains in gas phase. The characteristics of hydrochar depend on various parameters such as reaction temperature, time and raw material characteristics. The hydrochar can be used as co-fuel or as soil amendment while the process wastewater can be utilised for biogas production or recovery of macromolecules.

213

Optimization of Injector location on the Cylinder Head in a Direct Injection Spark Ignition Engine**Srinibas Tripathy***, Sridhar Sahoo and Dhananjay Kumar Srivastava

School of Energy Science and Engineering, IIT Kharagpur 721302, INDIA

srinibas@iitkgp.ac.in

The injector location and orientation on the cylinder head of a direct injection spark ignition engine greatly influence the performance, combustion and emission characteristics. As the cylinder head is the most crowded area, an in-cylinder investigation needs to be performed for optimization of the spark plug and injector location. In this study, a gasoline direct injection (GDI) injector location was optimized for the up-gradation of a port fuel injection (PFI) engine to direct injection engine. A computational fluid dynamics (CFD) tool of ANSYS Forte was used for the numerical simulation. The injector location was optimized based on the air-fuel homogeneity inside the combustion chamber at the time of ignition. A computational model was developed for the existing single cylinder PFI research engine, and full cycle simulation was performed for both motoring and combustion mode. An experimental analysis was performed and compared with the simulation results. It was found that the experimental in-cylinder pressure trace showed a good agreement with the simulation results. Prior to the numerical modeling, the GDI injector spray characterization was performed numerically and validated with the existing literature. The possible GDI injector locations were identified by diagnosing the cylinder head. The spray data was used at different possible locations and injected directly into the combustion chamber. The in-cylinder equivalence ratio at the time of ignition was presented for different injector locations and optimized based on the air-fuel homogeneity.

214

Automated cleaning of PV panels using the comparative algorithm and Arduino**Huzefa Lightwala***, Dipesh Kumar, and Nidhi Mehta

K.J. Somaiya College of Engineering, Mumbai Maharashtra 400077, India

huzefa.l@somaiya.com

The need for renewable sources of energy is increasing day by day. Out of these sources, the solar energy of the sun is one of the most promising sources as it is abundantly available. However, harvesting solar energy has its own problems. The energy density per unit area reaching earth at ground level is less. Further, PV cells can absorb up to 80% of incident solar radiation from the solar band but, only a small amount of absorbed incident energy is transformed into electricity depending on the conversion efficiency of the PV cells. This is further reduced when the panels get dirty due to dust deposition. From our observations, the efficiency drops by about 7% in 23 days. In large solar farms, a huge amount of energy loss is incurred due to dirty panels and at the same time, a huge amount of water is spent on cleaning. Hence an efficient and automated cleaning system that knows exactly when the panels need cleaning, needs to be developed. We have thus developed an automated cleaning system using the comparative algorithm for cleaning and the Arduino for the automation of the same.

215

Modeling and Simulation of Hydraulic Section of Basochu Hydropower Plant (BHP) using Real-Time Performance Data**Cheku Dorji¹, Thinley Tobgay², Yeshi Wangpo³, Pravakar Pradhan⁴**^{1,2,3,4} Centre for Renewable and Sustainable Energy Development, College of Science and Technology, Royal University of Bhutan, Bhutan

pravakar.cst@rub.edu.bt

This paper described the part of the on-going research, the dynamic modeling, and simulation of Bhutan's hydropower plants and the power transmission network. A realistic computer model of a hydropower plant is essential for the study of its static and dynamic behavior, linking the operation and control of generating units and the associated power system networks. A real-time physical test on the system would not be feasible, given the risks involved regarding operation downtime, unnecessary system disturbances, customer's disconnection and the revenue losses it would incur. However, the accuracy of the computer model explicitly demands; the competency to study, understand and analyze the overall physical system. This paper attempts to present the dynamic modeling and simulation of the hydraulic part of the fourth power plant, 64 MW Basochu Hydropower Plant based on its real-time measurement performance data. The mathematical model of any physical system can be built from the first principles modeling and their constitutive relationship of across and through variables, without much relying on the classical control systems engineering. The mathematical models are developed using input-output parameters and then further trained with the real-time data, both intuitively and experientially. The schematic layout of hydropower consists of a reservoir, water channel, surge chamber, penstock, turbine, governor control, and the power network. Each sub-component is described by its differential-integral equation followed by building blocks in the Matlab/Simulink. The Simulink blocks are then interconnected to form a complete model. The performance measurement was carried out on one of the generating unit, keeping the other unit identical. A total of 23 measurement files was recorded, considering the different operating scenarios of the power plant. Each measurement file consists of 11 different signals recorded simultaneously over a same length of time, using the National Instrument LabVIEW DAQ set up. The unknown parameters and the functional relationship of needle opening, deflector control, and turbine characteristics are derived from the stationary data table. The time constant parameters for water channel, penstock, and frictional coefficients were also computed from stationary points and the plant specifications. The simulated results were then compared with the real-time responses to validate the physical model. Based on the simulation results, the initial study of island mode operation and dynamic response of the plants were also carried out in this paper.

217

Study the Performance, Energy Generated and Cost Benefit Analysis of 15.6 kW Hybrid Solar PV System Installed at College of Science and Technology**Rinchen Dawa¹, Pema Tenzin¹, Tashi Dema¹, Gom Dorji², Dr. Tshewang Lhendup²**¹Department of Electrical Engineering, College of Science and Technology,²Department of Electrical Engineering, College of Science and Technology³Centre for Renewable and Sustainable Energy Development, College of Science and Technology

rkdawa14@gmail.com

This paper presents long term performance analysis of 15.6 kW hybrid solar photovoltaic system installed at the College of Science and Technology, Rinchending, Bhutan. Losses due to shading were analyzed and found that it effects only in winter. Energy and economic performance of the

system were calculated. From the result, the estimated cost of generation is US\$ 0.13/kWh. The system would not be financially viable at current electricity tar-iff in Bhutan.

218	Research on Biogas Production From Kitchen Waste- Experimental Analysis
------------	--

Pema Khandu¹, Sonam Zangmo¹, Tashi Peljor¹, Gom Dorji², Pravakar Pradhan³, Dr. Tshewang Lhendup⁴

¹Department of Electrical Engineering, College of Science and Technology, Rinchending, Phuntsholing, Bhutan, 0215323.cst@rub.edu.bt1, 0215336.cst@rub.edu.bt1, 02022013030.cst@rub.edu.bt1

²Department of Electrical Engineering, College of Science and Technology, gomdorji.cst@rub.edu.bt

³MSc. Energy Engineering, Head of Department, Executive Member of Centre(CRSED), Department of Electrical Engineering, College of Science and Technology, pravakar.pradhan84@gmail.com

⁴Centre for Renewable and Sustainable Energy Development, College of Science and Technology

The increasing demand on energy sources makes it to avail every available source. This paper presents on the experimentation of boiled rice water mixed with leachate from the food waste at the biogas plant installed at the College of Science Technology, near the student mess. The boiled rice water collected from the kitchen is being mixed with leachate at different ratios like 2:1 and 5:1, 2 and 5 being the amount of boiled rice water mixed leachate. For each set of ratios, a minimum of 20 days reading are plotted. The set of readings that each parameter contains are like the temperature, pH value and the amount of gas produced. Each parameter is then tabulated and plotted to draw necessary conclusions.

219	Production of biochar and bio-oil from waste biomass: Tectona grandis leaves and Musa acuminata Colla peels
------------	--

Tapan Pegu*, Minakshi Gohain and Dhanapati Deka

Tezpur University, Department of Energy, Tezpur 784028, Assam, India

*tapanpegu1995@gmail.com

Waste biomass as a renewable feedstock has been targeted more for the production of fuel. Waste generated from biomass can be transformed into clean energy and/or fuels by a variety of technologies as a means of sustainable energy recovery and sustainable minimization of overall waste. In the present investigation, waste collected from *Tectona grandis* leaves and *Musa acuminata* Colla (AAA group) peels were taken as biomass sources and they were converted to bio-oil and biochar by pyrolysis. Pyrolysis was performed at temperature 500 °C, 550 °C and 600 °C and the effect of temperature on the product yield was carried out in a fixed bed reactor with a heating rate of 40 °C/min with a nitrogen flow rate of 100 ml/min. Highest bio-oil yield from *Tectona grandis* leaves and *Musa acuminata* Colla were found to be 10.55 % and 10.20 % respectively at 550 °C, higher than the product obtained on other two temperature. But, highest biochar yield from *Tectona grandis* leaves and *Musa acuminata* Colla (AAA group) peels were found to be 31.85 % and 32.3 % at 500 °C respectively. The products were characterized by Fourier Transformed Infrared Spectroscopy (FTIR), Proton Nuclear Magnetic Resonance (1H NMR), Scanning Electron Microscopy (SEM), Energy Dispersive X-Ray (EDX) and X-Ray Diffraction (XRD) methods.

Biochars were found to be basic in nature and hence can be used for soil amendment, to increase the fertility of the soil and can also be used to reduce the acidity of the soil.

220	Performance and Degradation Analysis of High Efficiency SPV modules under Composite Climatic Condition
------------	---

Shubham Sanyal, Arpan Tewary, Rakesh Kumar, Birinchi Bora*, Supriya Rai, Manander Bangar, Sanjay Kumar

National Institute of Solar Energy, Gurugram, Haryana, India

*birinchibora09@gmail.com

High efficiency commercial solar panels have an appreciable solar energy to electrical energy conversion efficiency as compared to other Solar Photovoltaic (SPV) modules. It generates 36% more efficient power in panel over 25 years as compared to other modules and shows module wise highest efficiency of over 20%. The performance of an SPV module depends on environmental conditions and it degrades with the time of exposure. In the present work the degradation study of 100 kW high efficiency SPV power plant installed at NISE Campus, Gurugram, Haryana, India has been carried out after 2 years of installation in (Indian) composite climatic conditions. The annual degradation rate of the high efficiency technology is calculated from I-V measurement data of the individual modules of the power plant after subjecting them to visual inspection, thermal imaging and insulation resistance testing. The annual degradation rate of maximum power was found to lie in the range of 2.8% to 4.3% per year with a median of 3.9% for 2 years.

221	Energy Literacy of University Graduate Students: A Multidimensional Assessment in terms of Content Knowledge, Attitude and Behaviour
------------	---

Divya Chandrasenan¹, Jaison Mammen², Vaisakh Yesodharan³

¹University of Kerala, Trivandrum Kerala, India

²Bahir Dar University, Bahir Dar, Ethiopia

³APJ Abdul Kalam Technological University, Trivandrum, Kerala, India

Energy is considered as one of the world's largest industries and though we are constantly debating energy issues, our society is still woefully energy illiterate. To create energy literate citizenry, we must address the lack of energy literacy as a matter of urgency in both formal and informal learning environments. Energy literacy requires an understanding of the relationships between people, society and the environment, and the complex ways energy resources and use affect these relationships. The Ethiopian energy sector faces the dual challenges of limited access to modern energy and heavy reliance on traditional biomass energy sources to meet growing demand. While Ethiopia has seen dramatic economic growth in recent years, sustaining this growth into the future will require dramatic expansion of energy supply. So, efforts should be promoted to strengthen the energy efficiency improvement programs which may help the country meet future energy demand while contributing to sustainable energy development (Mondal et al, 2018). A knowledge on the extent of energy literacy among the citizens of Ethiopia will enable the policy makers in developing new strategies related to energy security. Now Ethiopia face an early critical test of its climate commitments as it prepares to impose binding caps on greenhouse gas emissions for 2020 and beyond. Ethiopia will for the first

time have to take a measure of responsibility for addressing climate change and participate in multilateral strategies to reduce greenhouse gas emissions. Hence, Ethiopia is trying to develop programs to secure its own energy security. In this backdrop, it is the need of the hour to find the extent of energy literacy among the students, especially the university students, who are considered as the future workforce of the nation. The present study analyses energy literacy from multidimensional perspectives and tries to group the student into various personas depending on their attitude and perceptions towards energy. The study enables curriculum planners in developing policies and practices in the area for the future generation.

223

Mathematical modelling and experimental validation for determining power loss in solar PV due to soiling

Priyanka Thite^{1*}, Amitkumar Patel², Ramola Sinha³, and Milind Marathe⁴

¹Department Of Mechanical Engineering

² K.J.Somaiya College of Engineering, Mumbai, India

*priyanka.thite@somaiya.edu

This report deals with universally known problem of dust accumulation also known as soiling in solar plants. This problem effects the energy production of solar plants. The following literature deals with the effects of certain parameters such as relative humidity, wind speed, dust particles, tilt angle etc. on solar photovoltaic soiling. The mathematical model developed serves as an efficient tool for determining the efficiency loss and power degradation due to dust accumulation on PV panels. This work also deals with experimental set up to validate the mathematical model developed. The experiment setup is at Mumbai located at west coast of India. Dust accumulation on glass samples over a period of 15 days are investigated and accordingly results are discussed.

224

Waste to Energy: Issues, Challenges, and Opportunities for RDF Utilization in Indian Cement Industry

Prateek Sharma, Pratik N Sheth* and B.N. Mohapatra

Birla Institute of Technology & Science, Pilani, Pilani Campus, Rajasthan

*pratik@pilani.bits-pilani.ac.in

Alternative fuels utilization in the cement industry has gained momentum from last one decade due to numerous advantages. Municipal solid waste (MSW) based refuse-derived fuel (RDF) is one of the promising alternative fuel identified for co-processing with coal to achieve the national target of 25 % thermal substitution rate (TSR) in Indian cement industry by the year 2025. However, even after consistent efforts of Government of India, cement industries and different stakeholders, percentage thermal substitution rate based on RDF is very low. This article highlights the issues, challenges and opportunities for Indian cement industry for RDF utilization with respect to the new ministry of housing and urban affairs (MoHUA) guidelines and changing scenario of RDF utilization in near future.

225	Design and Analysis of Fuel Intake System for HCNG Operated C. I. Engine
------------	---

Dr. Sanjay D. Yadav^{1*}

¹Automobile Engineering Department, Rajarambapu Institute of Technology, Rajaramnagar

*sanjay.yadav@ritindia.edu

Renewable energy is needed to be considered such as gaseous fuels like natural gas and hydrogen have more advantages compared to fossil fuels. Conventional fuels like petrol, diesel having hazardous emission. So we have to need to be attention on gas fuels to be used in vehicle. So need to be some development in carburetor for its best performance and emission level to lower one side. With regard to stringent emission legislation in the automotive sector, now onwards more focus on gaseous fuels for coming decades to control emission as per coming emission norms. In this research work focuses on the design and analysis of the fuel intake system as economical devices without major modification. The result shows reduction in emission with improved performance with optimum compression ratio and advanced timing.

226	Enhancement of Thermal Performance of ZrO₂ Nanofluid Flow in a Tube with Staggered Conical Strip Inserts
------------	--

S. Mohamed Iqbal* and Jee Joe Michael

*Department of Mechanical Engineering, Vel Tech University, Chennai 600062, India

The combination of using nanofluid with inserts has proved itself in attaining higher benefits in a heat exchanger such as radiator in automobiles, industries, etc. The thermal hydraulic performance of ZrO₂ nanofluid with different volume concentration of 0.1%, 0.25% and 0.5% and staggered conical strip insert with different twist ratio of 2.5, 3.5 and 4.5 were experimentally tested in the laminar flow regime through a horizontal test pipe section. The results obtained revealed that by using staggered conical strip inserts, the thermal performance improved up to 68.74% in the forward arrangement and 145.03% in the backward arrangement for the twist ratio of 2.5 and 0.5% volume concentration of ZrO₂ nanofluid. The thermal performance factor with conical strip inserts were consistently greater than 1. The highest thermal performance ratio of 1.62 was obtained for the backward arranged conical strip insert with 2.5 twist ratio and volume concentration 0.5% ZrO₂ nanofluid. Empirical correlations were developed based on the obtained experimental data for the Nusselt number and friction factor.

227	De-rating comparison of an inverter and non-inverter split air conditioning system
------------	---

Shabad Singh, Vijay Singh, Naresh Nagar and Jyotirmay Mathur

Malviya National Institute of Technology Jaipur-302017, India

lns@springer.com

The present paper aims to compare the performance of the inverter technology based and non-inverter technology based split air conditioning systems in the controlled environment. Recently, the inverter technology has been introduced in the split air-conditioning system. The inverter-driven split

air-conditioning system is very productive in terms of energy saving in small residential buildings. This experimental investigation deals with the comparison of the performances of the both types of systems at varying cooling loads and at varying outdoor temperatures. The whole experimental investigation was carried out in the controlled environment (Psychrometric chamber). A conventional air conditioner and an inverter based air conditioner of the same capacity (1.5 TR) were tested in the psychrometric test chamber for outdoor temperature ranged from 35 to 45 and indoor chamber cooling load ranged from 2 kW to 4 kW. The Results shows that Coefficient of performance (COP) of conventional air conditioner decreases with a decrease in cooling load from its rated capacity, but for inverter air conditioner, it increases at part load operation. Also for the same cooling load, the performance decreases with increase in the outdoor temperature for both types of the air conditioners. According to our experimental investigation, about 18.5 % decreases in the COP from a cooling load of 4 kW to 2 kW for conventional air conditioner and for inverter air conditioner the COP increases by 24.5 % for a decrease of cooling load from 4 kW to 2 kW.

228

Experimental and Computational Study of Phase Change Material Based Shell and Tube Heat Exchanger for Energy Storage

Badal Kudachi^{1*}, Srikant Guthula¹, Prabhav Jayaprakash¹, Alex Aaron¹, Simran Joy¹

¹ Department of Mechanical Engineering, Fr. C. Rodrigues Institute of Technology, University of Mumbai, Vashi, Navi Mumbai, PIN-400703, Maharashtra, India

*badalkudachi@gmail.com

The storage of thermal energy is an important issue which needs to be addressed. The wastage of heat energy, such as in an automobile or thermal power plant exhausts, means the loss of useful heat energy that could have been reused considering the present energy crisis scenario. The Phase Change Material (PCM) plays one such role in harnessing, storing and reusing the waste heat energy. These materials have a unique property of changing its phase from solid to the liquid whenever some heat energy is provided to it. It utilizes a latent heat storage method at a fairly constant temperature. In the present study, the shell and tube heat exchanger (HE) with thermal energy storage containing PCM as OM65 (a mixture of organics) is tested for its heat storage capability. This PCM changes its phase at approximately 55°C to 65°C, and its operating range is 60°C to 70°C. Performance of heat exchanger is investigated for a single round of temperatures for both charging and discharging cycles. The experiment results are compared to simulation results. It is found that the phase change for charging takes place at 56°C for experiment and 59°C in simulations. The experimental results are in close agreement with the simulation results. It can be concluded that heat energy which is stored in the HE can be extracted effectively and used for suitable applications which operate at reasonably high temperatures.

229

Predict the Effect of Combustion Parameter on Performance and Combustion Characteristics of Small Single Cylinder Diesel Engine**D.K.Dond* and N.P.Gulhane**

Veermata Jijabai Technological Institute, Mumbai, India

*dpkdnd@gmail.com

To predict the effect of change in combustion parameter which can be achieved through newly CRDI system on the performance of small cylinder diesel engine, a MATLAB programme based on a mathematical model has been developed. Developed mathematical model results are verified by comparing with those obtained through a trial on conventional small diesel engine and found very well matches. Further made changes in modelling for a different combination of combustion parameters such as injection pressure and injection timing and observed the effect of the same on performance and combustion characteristics of the diesel engine. These estimates are most useful for understanding basic engine performance as well as assessing modifications as regards high injection pressure system, valve and cam sizing, other geometrical parameters and various fuels.

231

Experimental investigation of a biogas fueled diesel engine at different biogas flow rates**Naseem Khayum*, S. Anbarasu and S. Murugan**

Department of Mechanical Engineering, National Institute of Technology, Rourkela, India

*abdulkhayyum.nitr@gmail.com

The evolving energy demand and depletion of fossil fuels are the major drive towards the presage on economic growth and energy security. These challenges make necessary to find out an alternative energy resource in around the globe. The substitution of petroleum products by various biofuels especially in the transport sector could be a potential supporter for the feasible environment. Hence, in this present study, a single cylinder, 4-stroke, direct injection (DI) diesel engine was changed to work on a dual fuel (DF) operation with biogas (crude) –diesel; where, for starting the combustion, diesel was used as injected fuel, while, biogas used as a primary gas which is supplied through the intake of the engine. During the DF operation, the effect of varying the biogas flow rates from 0.25 to 1 kg/h with an intervals of 0.25 kg/h was studied at different engine loads. At each step, the percentage replacement of biogas; and performance and emissions analysis of this study were compared with standard setting of the engine with diesel, and the results are presented in this paper.

234

Maximum Power Extraction in Grid-Connected Photovoltaic System using Adaptive Neuro-Fuzzy Inference System**Sachpreet Kaur***, Tarlochan Kaur and Rintu Khanna

Punjab Engineering College, Chandigarh, India

*sachpreetkaur7433@gmail.com

Researchers worldwide are focusing on advanced control strategies to exploit power available from solar PV modules efficiently. The power obtained from a PV module is greatly influenced by various parameters including temperature, shading, solar irradiation etc. Consequently, to extract maximum power from PV modules suitable maximum power point tracking (MPPT) controllers need to be installed. The conventional methods like Perturb and Observe, Incremental Conductance etc. though easy to implement face certain challenges. These methods have low tracking speed, poor convergence and face rapid variations in output power even under steady state conditions. On the other hand, artificial intelligent (AI) techniques are more robust and can effectively handle non linearity in characteristics of PV modules. In this research paper, AI based Adaptive Neuro-Fuzzy Inference System (ANFIS) is developed to extract maximum power from PV modules. The ANFIS controller directly takes irradiance and temperature as inputs to give the desired output. The output of the controller is voltage corresponding maximum power. A DC-DC converter is used in a grid connected PV system. Simulation results reveal satisfactory tracking of maximum power using ANFIS controller. It has been observed that the ANFIS controller shows fast response and give higher accuracy in comparison to Perturb and Observe and ANN based controllers.

236

Characteristics of an Indigenously Developed 1 kW Vanadium Redox Flow Battery Stack**S. Jayanti***, R. Gundlapalli, R. Chetty, C.R. Jeevandoss, R. Kothandaraman, D.S. Monder, R. Rengaswamy, P.V. Suresh, K.S. Swarup, U.V. Varadaraju, V. Gol- langi and L. Satpathy

Indian Institute of Technology Madras, Chennai 600036, INDIA

*sjayanti@iitm.ac.in

Efficient and high-power electrical energy storage is a key technology to harness renewable sources of energy. Vanadium redox flow battery (VRFB) systems have emerged as strong contenders for large-scale energy storage applications. The paper presents the characteristics of an indigenously developed 1 kW VRFB stack of two designs. The fabrication of stack was preceded by a large amount of cell-level studies; important characteristics of interest to a design engine such as materials of construction, cell sizes, operating conditions, power, charge/discharge capacity, energy efficiency and cycling behaviour, are reported here. The project aims to develop eventually a 5 kW/25 kWh redox flow battery system capable of drawing electrical power from solar PV panels or the main grid, as necessary, and deliver uninterrupted power to a community of mixed DC/AC users.

237

Estimation of state of health (SoH) of lithium ion battery based on varying cycle rates and constant voltage profile**Sudipta Bijoy Sarmah¹ and Pankaj Kalita^{2*}**^{1, 2} Centre for Energy, Indian Institute of Technology-Guwahati, India

Pankaj.kalita@gmail.com

In recent years, Electric Vehicle (EV) has received enormous acceptance for their performance and efficiency. During commercialization of EV, lithium - ion battery plays an impactful role due to its lucrative characteristics such as small size, high energy and power density, high columbic efficiency, long cycle life and low self-discharge. But obtaining maximum efficiency from each cell in a battery pack is a challenging task. Numerous research work is performed in order to understand and moderate the degradation process of lithium-ion batteries. Degradation leads to lowering its proficiency, primarily due to capacity and power fade. In this paper the relationship between amount of transferred charge, corresponding transferred charge time and their relationship with capacity is studied. Performance features such as state of health (SoH) of the lithium-ion battery is also investigated by analyzing its charge-discharge characteristics.

238

Numerical Investigation of drag and lift coefficients on a fixed tilt ground mounted photo-voltaic module system over inclined terrain**Imran Ismail Sheikh, Dr. R S Maurya**

Dept. of Mechanical Eng., Sardar Patel College of Engineering, MUMBAI

The present study deals with the 2D and 3D steady state Reynolds-Averaged Navier-Stokes (RANS) simulations for the fixed tilt ground mounted photovoltaic (PV) by computational fluid dynamics (CFD). Here, we are considering shear stress transport k-omega (SST k- ω) turbulence model and the system is supposed to be immersed in atmospheric boundary layer (ABL). Initially the 2D and 3D numerical models are validated with the available experimental results of the literature. The work focuses on the evaluation of drag and lift coefficients on photovoltaic systems mounted over the inclined terrain (hills). Three different profile of hills were considered with height of 100m and ratio of height to length 0.75, 1 and 1.25 respectively over the consecutive seven rows of solar array. Also, the influence of panel length, row length, spacing factor between consecutive panels, clearance height from the ground, wind speed, wind direction and angle of tilt is studied parametrically.

239

Dynamic Demand Response through Decentralized Intelligent Control of Resources**Arvind M T* and Anoop R. Kulkarni**

Amplebit Energy Solutions, Bangalore 560075, India

*arvind.mt@amplebitenergy.com

With the advent of Machine Learning and IoT capabilities built into resources, it is becoming feasible to implement Data Analytics based strategies where the Loads & Renewable Resources dynamically predict and publish their ability and extent of reduction or generation. This paper explores how the traditional Demand Response programs can be made automated, independent and dynamic - in the

sense of allocation of load reduction dynamically to various resources, based on the data published by them regarding how much each of them is able to contribute. This will facilitate extending the Demand Response paradigm itself - by making it a tool to achieve load-curve tweaking at any point of time, rather than using it just when demands peak. With the increasing penetration of Renewable Power generators and EV loads which are highly variable in nature, we believe our Dynamic Demand Response paradigm would be of high utility for future Smart Grids.

240	Transient Analysis of Pressurizer Steam Bleed Valves Stuck Open for 700 MWe PHWRs
------------	--

Deepraj Paul*, S. Pahari, S. Hajela, M. Singhal

Directorate of RS&A, Nuclear Power Corporation of India Limited, Mumbai, India

*deepraj@npcil.co.in

Indian Pressurizer Heavy Water Reactor (700 MWe) is a horizontal channel type nuclear reactor with partial boiling present at the outlet of channels. Heat which is generated due to fission reaction in the reactor core is transferred to primary coolant through primary heat transport system. There are two loops in the primary heat transport system and each loop is in the shape of figure-of-eight and has two steam generators connected in series. The steam generated in the steam generators through the transfer of energy from primary side drives the turbine for generation of power. Primary Heat Transport System (PHTS) pressure control is done with the help of pressurizer. It has heaters and two pressurizer steam bleed valves (PSBVs). Pressurizer level control is achieved by feed and bleed control system. In this work, it is postulated that both the pressurizer steam bleed valves are stuck open. The scenario can be the result of faulty pressure control signal and is thus analyzed in this work. The impact of such an event on the overall safety of the reactor is hereby analyzed using in-house developed computer code ATMKA-T. ATMKA-T code is a coupled thermal hydraulics and 3D neutron kinetics computer code which captures the plant dynamics.

241	Transient Analysis of Net Load Rejection for 700 MWe IPHWRs
------------	--

S. Phani Krishna*, S. Pahari, S. Hajela, M. Singhal

Directorate of RS&A, Nuclear Power Corporation of India Limited, Mumbai, India

*pkrish@npcil.co.in

Indian Pressurizer Heavy Water Reactor (700 MWe) is a horizontal channel type nuclear reactor with partial boiling at the channel outlet. Heat generated due to fission reaction in the reactor core is transferred to primary coolant through primary heat transport system. There are two loops in the primary heat transport system and each loop is in the shape of figure of eight and has two steam generators connected in series. The steam generated in the steam generators through the transfer of energy from primary side drives the turbine for power generation. There is a Generator Circuit Breaker (GCB), which is between Generator and Generator Transformer and another Generator Transformer Circuit Breaker (GTCB) which is in between Generator Transformer and the grid. In the case of Net Load Rejection (NLR), the GTCB opens to disconnect generator from the grid. GCB remains closed and the Generator continues to supply the buses to which Unit Transformers (UTs) are connected and continue to feed the house load. Transient analysis to simulate the timeline along

with the sequence of events and study various parametric variation of the power plant are performed using in-house developed computer code ATMIKA.T. ATMIKA.T code is a coupled thermal hydraulics and 3D neutron kinetics computer code which captures the plant dynamics.

242

Experimental Investigation on Optimization of Karanj Oil (*Pongamia Pinnata*) Injection Temperature as a Substitute for Diesel in C. I. Engines

Patil Vijay S.¹, Shelar Mahesh¹, Anuradda Ganesh²

¹K. K. Wagh I. E. E. R., Nashik, v.s.patil@kkwagh.edu.in, mnshelar@kkwagh.edu.in

²Cummins Technologies India (P) Ltd., Pune

Current petroleum crises, increasing prices and uncertainties concerning petroleum availability has renewed the interest in vegetable oils as diesel substitute. Performance of diesel engine operated with Karanj oil shows that, it can be used as a complete substitute for diesel in preheated form. Engine performance and emissions are influenced by basic differences between diesel and Karanj oil properties such as calorific value, viscosity, density and molecular oxygen content. Preheating oil leads to change in these properties which can enhance engine performance and reduce emissions. Thus, the inlet fuel temperature is optimized with the use of Karanj oil for more than 50 hours. Slight increase in emissions and considerable increase in exhaust temperature was observed with no change in the specific fuel consumption.

244

Thermodynamic analysis of PV-TEG hybrid system

Ravita Lamba^{1*}, Richa Parmar¹, S.C. Kaushik², A.K.Tripathi¹, Chandan Banerjee¹, Sanjay Kumar¹

¹National Institute of Solar Energy, Gurugram, Haryana-122003, India

²Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India

*ravitalamba.lamba247@gmail.com

In this paper, the thermodynamics analysis of an irreversible CPV-TEG hybrid system has been studied to cover the full solar spectrum. Siemens SP75 PV module and commercially available Bi₂Te₃ TE module have been used for this study. The thermodynamic modeling and MATLAB simulations have been carried out for feasibility analysis of the hybrid system. The irreversibilities caused by the various heat transfer process are calculated second law of thermodynamics. The effects of the full solar spectrum have been considered by varying the solar radiation from 100 W/m² to 1000 W/m². Further, the effect of the TEG junction temperature ratio, concentration ratio, TEG current, Thomson coefficient, irreversibilities or exergy destruction and the incoming solar radiation exergy have been studied. The results showed that the Thomson effect has an adverse effect on the performance of the hybrid system and the irreversibilities increase with increase in concentration ratio, C. It has been concluded that the higher values of the irreversibilities make the system less inefficient and significant improvement is required since the elevated temperature may result in the formation of the hot spots in the PV module. The results of this analysis may be helpful in designing of practical CPV-TEG hybrid system.

245

A comparative experimental investigation of improved biomass cookstoves for higher efficiency with lower emissions**Sandip Bhatta, Dhananjay Pratap, Nikhil Gakkhar* and J.P.S Rajput**

Sardar Swaran Singh National Institute of Bio-Energy, Kapurthala, Punjab 144601

*Indianikhil.mnre@gov.in

Traditional biomass cookstove emits high level of incomplete combustion particulates which leads to air pollution and causes negative impact on human health and environment. In the current research work, an improved biomass cookstove (IBC) is designed and tested out by using woody fuel to reduce carbon emissions with higher efficiency. The performance of IBC was evaluated in terms of energy efficiency, power output and emission reduction potential. For the experimentation, two different designs of IBC were taken with varying insulation material in between. The first design included Plaster of Paris (POP) as insulating material, while the other has glass wool as insulating material. The results showed that the IBC with glass wool insulating material exhibits higher thermal efficiency (32.66%) with lesser CO level (29.36 ppm), and PM 10 emissions (3.64 mg) as compared to IBC with POP. The maximum power output of 7.3 W was obtained for glass wool based IBC. The experimental results of IBC were compared with the results of traditional cookstove available in the literature. In the end it was concluded that the designed IBC has performed better in terms of efficiency and emissions.

247

Assessment of Floating Solar Photovoltaic (FSPV) Potential in India**Ashish Kumar*, Ishan Purohit , Tara C. Kandpal**

Centre for Energy Studies, Indian Institute of Technology, Delhi, India

*ashishkmr.me@gmail.com

This study deals with an assessment of the potential of utility scale Floating Solar Photovoltaic (FSPV) plants in India. Global Solar Atlas (GSA) and Global Reservoir and Dam (GRanD) databases are used for examining water bodies such as man-made reservoirs used for hydroelectricity generation, irrigation, drinking water purposes and few lakes in India. Considering 10% coverage of water surface area by FSPV systems, a gross potential estimate of 124.6 GWp is arrived at. Further screening by fixing technological and other criteria limit the potential to 111.9 GWp.

248

Effect of non-revenue water reduction in the life cycle of water-energy nexus: A case study in India**Rajhans Negi, Vipin Singh, Munish Chandel***

Environmental Science and Engineering Department Indian Institute of Technology Bombay

*munish.chandel@gmail.com

In developing countries due to improper management of water supply systems, a bulk of treated water is lost during transmission or is unmetered. This unaccounted water is termed as non-revenue water due to which, an additional amount of water is supplied by the authorities adding to more energy and environmental burdens. The municipal corporations are attempting to reduce non-revenue water to make water supply systems sustainable. This study quantifies the water and energy nexus in the municipalities of the Pune Metropolitan region and evaluates the change in environmental impacts when the non-revenue water is reduced. Environmental impacts of two scenarios vis-à-vis, Business as usual (BAU) and Government established targets (GET) were evaluated through life cycle assessment approach using GaBi software. The environmental impact categories for scenarios were global warming, acidification, photochemical ozone creation and eutrophication. Results showed the average energy intensity for the treatment and supply of water in Pimpri Chichawad municipal corporation was 0.29 kWh/m³. The global warming potential ranged between 90 million kg-CO₂e in year 2017 to 160 million kg-CO₂e in year 2047 for BAU scenario and dominated the environmental impacts. After controlling non-revenue water to 15%, it was possible to reduce 24% of environmental burdens from water supply systems. This study represents the case of a metropolitan region in India and depicts the advantages of non-revenue water reduction in terms of environmental benefits in water supply systems.

249

Policy intervention for promoting effective adaptation of rooftop solar PV systems**Sabreen Ahmed*, C. Vijayakumar and Arjun D. Shetty**

The Energy and Resources Institute (TERI), India

*sabreen.Ahmed@teri.res.in

The paper focuses on the targets set under India's national solar mission and cumulative installed capacity of Solar PV system. Analysis of the status of implementation of the solar mission reveals that development in rooftop solar category has been extremely slow. A comparison of solar policy of five Indian states brings out the most effective policies adopted till date. The paper recommends an economic model for promoting rooftop solar PV system along with demand side management.

250

Improved Dispatchability of Solar Photovoltaic System with Battery Energy Storage**Sheikh Suhail Mohammad* and S. J. Iqbal**

National Institute of Technology, Srinagar, India

*ssuhail73@gmail.com

Photovoltaic power is variable in nature as its output power continuously changes with the change in the solar irradiance level. This paper presents a method to balance power between the fixed power demand and the variable photovoltaic power. Perturbation and Observation algorithm is used to operate the photovoltaic system at maximum power point so that maximum power can be extracted from it. When solar photovoltaic power changes with the solar irradiance level there is a power mismatch between the generated power and load power demand due to which the voltage across the DC link capacitor changes. This power mismatch is overcome by connecting battery energy storage device with DC link capacitor through bidirectional power converter. The bidirectional power converter is controlled to operate the battery in charging and discharging modes which help in power balance thus stabilizing the voltage across DC link capacitor. Maintaining constant voltage across the DC link capacitor has many advantages such as connecting different energy storage devices directly to DC link capacitor, feeding DC loads and it improves power quality when the inverter is operated and controlled as voltage source converter.

251

Optimization of Second Generation Ethanol Production Cost Based on Regional Resource Availability**Rashi Dhanraj¹* and Yogendra Shastri¹**¹Chemical Engineering Department, Indian Institute of Technology Bombay, Mumbai 400076, India

*dhanrajrashi@gmail.com

Biofuels are used as an alternative for fossil fuels to reduce the stress on fossil fuel and to reduce import of fuels from other countries. In 2003 Government of India (GoI) made 5% blending of ethanol with petrol mandatory. In India ethanol is produced from molasses which are not sufficient to meet the 5% target. Using lignocellulosic biomass for ethanol production can help to reach the 5% target. The choice of feedstock for ethanol production should consider the water consumed by the crop variety since there is a limited water supply. Especially for a water stressed country like India, it is important to look into the water footprint of the crop as well as the availability of rainfall and groundwater to allocate land to a particular crop in a particular district. The feedstock with less water footprint may not be the most economic one, thus it is important to look into factors, such as, how much bioethanol can be produced per ton of feedstock, the price of feedstock and cost of production. Therefore, an optimization problem was formulated to minimize the production cost of ethanol, where agricultural land is the decision variable and water supply like rainwater and groundwater are constraints. The objective of this work is to allocate agricultural land to crops like sugarcane, cotton, wheat, and sorghum in districts of Pune, Kolhapur, Sangli, Satara, and Solapur so that enough feedstock is available for the production ethanol that can meet demand while considering the water stress in that region. A linear programming problem was formulated on GAMS 25.0.3 and CPLEX® solver was used to solve the problem. The program

was simulated for three different scenarios to see which factors influence the water and land resources used during the life cycle of ethanol for cradle to gate condition.

252

Numerical Investigation of the Performance of Pump as Turbine with Back Cavity Filling

Rahul Gaji* , Ashish Doshi and Mukund Bade

Sardar Vallabhbhai National Institute of Technology, Surat / Annasaheb Dange College of Engineering and Technology, Ashta, India

*rahul.gaji07@gmail.com

The objective of this paper is to investigate the internal flow profile of ‘pump as turbine’ (PAT) and influence on the internal flow physics due to novel modification as back cavity filling (BCF). This study is carried out by numerical simulation using fluent software for low specific speed ($N_s=19.9$ rpm) end suction centrifugal pumps used in turbine mode. As it is very difficult to visualize the internal flow physics in turbo-machines due to use of nontransparent materials, best approach is to use flow simulation software such as fluent, which gives insight and internal flow physics helping to understand and improve the system performance. Internal flow hydraulics indicates various losses in the impeller as well as clearly shows main flow region, which contributes mainly in the power generation. Due to insertion of filling material in the back cavity, shaft torque increases also there is reduction of the secondary flow and leakage of main flow into the back cavity, which results into an improvement in the performance of PAT. Large wake is observed at pressure and suction side of impeller blades for without-BCF and with-BCF stage of PAT. At overload condition, wake is even wider prevents the movement of fluid from blade passages and contributing to the hydraulic losses. Further, this study can be extended for optimization of shape and size of fill component for improvement in the performance and life of PAT.

253

Mining representative load profiles in commercial buildings

Kakuli Mishra*, Srinka Basu, and Ujjwal Maulik

Department of Computer Science and Engineering, Jadavpur University, Kolkata- 700032 India

*kakulimishra.94@gmail.com

Benchmarking the load patterns in buildings is an important problem that can help in energy savings and automatic anomaly detection. This paper proposes a framework for benchmarking the load profiles in commercial buildings, temporal knowledge discovery from the load profiles and anomaly detection. We use clustering to group the similar power consumption patterns. For each cluster, we discover a set of load profiles which can benchmark other load patterns in the cluster, named as Representative Load Profile (RLP). RLPs have been discovered using symbolic representation of the time series data. The proposed methodology reveals insight about load consumptions of commercial buildings in Ireland.

254

A Simplified Non-iterative Method for Extraction of Parameters of Photovoltaic Cell/Module**Kumar Gaurav***, Neha Kuumari, S. K. Samdarshi and A.S. Bhattacharyya

*Centre for Excellence in Green and Efficient Energy Technology, Central University of Jharkhand, Ranchi 835205, Jharkhand, India

Current interest in the development of a photovoltaic performance model is intended to make it more robust, broad-based and inclusive in the light of steady improvement in established technologies and emergence of new photovoltaic technologies. In all the cases reliable estimation of output power available from cell/module in spatial and temporal dimensions is one of the most important aspects of a photovoltaic performance model. The single diode five-parameter model is of interest because it is simple, requires only a small number of input data, works satisfactorily under normal operating conditions of the cell and has served the need till date. In this work a reasonably simplified analytical method is proposed for calculating all the five parameters of a single diode model of solar cell/module. Surprisingly, it resulted in reasonably better prediction. Also the method could be an easy and quick computational tool for long term performance prediction under commonly encountered operating conditions. It has been demonstrated for two entirely different technologies like multi-crystalline silicon and next generation organic photovoltaic solar cell.

255

Thermo-physical properties of agricultural residues for producer gas production using thermo-gravimetric analysis**Kumar P.^{1*}**¹ Centre for Rural Development and Technology, Indian Institute of Technology, Hauz Khas,

*praveen.dimension@gmail.com

The thermal degradation behaviour and kinetics of biomass can be employed to understand the thermal behaviour and constituent of biomass degradation rate prior to gasification. Thermo physical characteristics of agricultural residues in order to facilitate its utilization and processing for syngas production in the gasifier. Suitability of biomass for gasification and power generation was prejudged by its thermo-physical properties. The present study was aimed to analyse the thermophysical behaviour of corn cob (CC) and eucalyptus (EU) residues for gasification using thermo gravimetric analysis (TGA). The kinetic parameters were evaluated by FWO (Flynn-wall-Ozawa) methods at heating rates of 10°C/min. Mass loss from agriculture residue occurs in three steps viz. first moisture removal, second was main component (cellulose and hemicellulose degradation) decomposition and third dissociation of other organic matters. The cellulose and hemicellulose in biomass were playing an important role in combustion and pyrolysis. The results showed that corncob was sensitive to heat having lowest lignin content and activation energy, therefore, it is best-suited feedstock for gasifier engine system for producer gas generation in a remote area like village and hill station.

256	Design, Analysis and Hardware Implementation of Modified Bipolar Solid-State Marx Generator
------------	--

Neelam S. Pinjari* and Dr BinSdu

Fr. C Rodrigues Institute of Technology, Navi Mumbai, India

*neelam.pinjari@gmail.com

Bipolar Marx generator generates high voltage, repetitive pulse with both positive and negative half, which is being used for applications like food processing industries, medical fields, agricultural and environmental. This paper deals with design, simulation, implementation and testing of the bipolar Marx generator. Simple monopolar Marx generator is modified by connecting an H- bridge circuit to the last stage. Ten stage Bipolar Marx generator topology with specification, output voltage 10 kV, 10% voltage droop, pulse repetitive frequency (PRF) - 1kHz and pulse width of 5μsec is designed and simulated using MATLAB (R2009a). The most suitable inductor and resistor required for charging are selected using transfer function modeling. A two-stage prototype is implemented to validate the design. Pulses for triggering the Marx switches and the H-Bridge switches are developed using LPC2148 arm controller. Hardware circuit is tested with an input of 100V and PRF of 110Hz. During erection the full voltage appears across the switches in the H-Bridge. Hence this can be used only for few kilovolts.

257	Viability Study Of Stand-alone Hybrid Energy Systems For Telecom Base Station
------------	--

M. Siva Subrahmanyam* and E. Anil Kumar

MVGR College of Engineering(A), Vizianagaram 535005, India

*m.sivasubrahmanyam@mvgce.edu.in

Telecom sector is playing an important aid for rapid progress of various segments of the economy. These telecom towers are increasing heavily with the increasing population. In rural areas, more power shortages lead to usage of conventional energy resources which lead to high costs because of more fuel consumption and increase in environmental pollution. To tackle this situation, the present work aims to study the viability of individual hybrid renewable power system for telecom tower in Vizianagaram. Initially, the electrical load on hour basis of telecom tower is estimated for all months in a year for the telecom tower. Monthly solar irradiance and wind speed using NASA meteorology and monthly biomass availability data is collected from the records of ministry of new and renewable energy. Different hybrid energy systems have been designed based on technical and economical features of various components. Simulations are carried out by HOMER software for solar-wind, solar-biomass, and solar-fuel cell hybrid energy systems. Economics of different hybrid energy systems are compared. The values indicate that the solar-biomass hybrid energy system is economically viable among different systems considered in the present work. The optimal size of solar-biomass hybrid energy system is a combination of photovoltaic cell of 28.4 kW capacity and biomass of 6 kw capacity and converter of 4 kW with a net present cost of ₹ 22,68,578 with initial cost of ₹ 1.16M and with a payback period of 7.46 years.

258

Effect of temperature and salt concentration on the properties of electrolyte for sodium ion batteries**Bharath Ravikumar***, **Surbhi Kumari**, **Mahesh Mynam** and **Beena Rai**

Tata Research Development and Design Centre, TCS Innovation Labs, Tata Consultancy Services, Pune, Maharashtra, India -411013

*r.bharat@tcs.com

Electrolyte plays an important role in the success of rechargeable batteries. Identification of appropriate electrolyte materials for sodium based batteries is an active research area today. Using molecular dynamics method, we simulate a widely studied electrolyte for sodium ion batteries (SIBs): NaPF₆ salt in ethylene carbonate solvent. The roles of temperature and salt concentration on the structural and dynamic properties of the electrolyte are studied. Temperature and the salt concentration affect the molecular structure of the solution. The electrolyte tends to form contact-ion-pairs and multi-ion aggregates at higher temperature and concentration. An in-depth understanding of the effect of temperature and concentration on various properties of the electrolyte that define the rate and safety characteristics of the battery is required to rationally guide the design of electrolytes for SIBs.

259

Carbon deposition on the anode of a solid oxide fuel cell fueled by syngas – A thermodynamic analysis**Rakesh N.*** and **S. Dasappa**

Centre for Sustainable Technologies, Indian Institute of Science, Bangalore

*rakeshn@iisc.ac.in

Decentralized power generation can be used to address the problem of energy crisis at remote locations. Use of renewable energy helps to provide clean energy and the gasification route helps to use locally available solid fuels to generate a gaseous fuel for efficient prime movers. Syngas generated from the gasification of biomass/coal can be used in solid oxide fuel cells to generate electricity for decentralized power generation. While using syngas in SOFCs, the presence of carbonaceous compounds like CO and tar could potentially result in carbon deposition on SOFC anodes, eventually resulting in anode and cell degradation. Thermodynamic calculations using NASA CEA equilibrium analysis were carried out to provide a first-hand understanding of carbon deposition during syngas fueled operation. The studies point to the need for higher hydrogen/steam content in fuel or a higher cell operating temperature to reduce carbon formation on SOFC anodes.

260

Numerical Study on CO₂ injection in Indian Geothermal reservoirs using COMSOL Multiphysics 5.2a

Nandlal Gupta* and Manvendra Vashistha

Pillai HOC College of Engineering and Technology, Raigad MH 410207, India

*nandlalgair1@gmail.com

India has the potential to generate 10600 MW of electricity to meet the electricity demands, especially in rural areas from 400 thermal springs across the nation. Due to high investment cost and acute work in R&D in geothermal prospects of India this clean and reliable technology is not yet explored to its fullest potential. In this work, we have analyzed the performance of two different geothermal system namely Engineered Geothermal System (EGS) and Carbon Dioxide Geothermal System (CPG) utilizing carbon dioxide and water as working fluids in geological subsurface using COMSOL Multiphysics 5.2a.

261

Modification in the Rotor of Savonius Turbine to Reduce Reverse Force on the Returning Blade

Ramarajan J* and Jayavel S

Department of Mechanical Engineering, IITDM Kancheepuram, Chennai-127, India

*mdm18d003@iitdm.ac.in

In the present study, conventional semi-circular rotor blades of Savonius turbine are modified to reduce the reverse force on the returning blade. The modification is in the form of converging or diverging passage in the blades. The effect on such passages on the net drag has been numerically studied. Two- dimensional transient simulations are carried out to analysis the performance of modified blades. ANSYS Fluent 15.0 is used for the simulations. The performance of the turbine has been quantified in terms of power and torque coefficients. From the results, for the preferred geometry modification, drag reduction in the returning blade has been observed. However, there is reduction in the net drag as well.

262

Design and Fabrication of Grating based Filters for Micro-thermophotovoltaic Systems

M V N Surendra Gupta, Ameen E, Ananthanarayanan Veeraragavan and Bala Pesala*

The University of Queensland, Queensland, Australia

*balapesala@gmail.com

Micro-thermophotovoltaic systems are an appealing alternative as portable power generators with high energy density and longevity. Recent advances in nano-fabrication has enabled design of spectrally selective thermal emitters matched to the low bandgap PV cells. Here, we propose a one-

dimensional amorphous silicon grating based structure on quartz substrate as selective filter. The simulations are performed to optimize the grating parameters to minimize the transmission of below bandgap photons for GaSb PV cell (cut-off wavelength of 1.8 μm). The fabrication of the optimized design is carried out using interference lithography. The fabricated grating parameters are grating period (2.49 μm), duty cycle (39 - 41 %) and grating thickness (520 ± 30 nm). The fabricated filter is characterized using an optical set-up and the obtained transmission spectrum when convoluted with blackbody spectrum at 1500 K, showed that 71.17 % of above bandgap photons are transmitted and only 24.3 % of below bandgap photons are transmitted. Therefore, approximately 75 % of the below bandgap photons are reflected by filter which provides the advantage of reduction in heat loss and enhancement of the combustion which contributes to the overall increase in TPV system efficiency.

263

A systematic investigation on evaporation, condensation and production of sustainable water from novel designed Tublar Solar Still

Mihir Lad, Nikunj Usadadia, Sagar Paneliya, Sakshum Khanna, Vishwakumar Bhavsar, Indrajit Mukhopadhyay, Devang joshi, Abhijit Ray*

Department of Solar Energy, Pandit Deendayal Petroleum University, Raysan, Gujarat-382007

*abhijit.ray@sse.pdpu.ac.in

In current scenario, mammoth task is the management of the portable water supply. Clean water is considered to be the fundamental need for humans. In this study, we explore the performance of new design for the solar desalination integrated with parabolic line concentrator. The newly designed system consist of two separated chambers i.e. the evaporation and condenser chamber having evacuated tube placed at the focal line of the parabolic trough collector and thermic oil as a heat transferring medium. A newly designed steam separator was used to separate steam and hot water in the condensation chamber. A set of experiments were carried out to investigate the evaporation, condensation and distilled water production performance, independently. The temperature obtained at the copper tube surface was 1350 $^{\circ}\text{C}$. The temperature of condenser plate was found to be 350 $^{\circ}\text{C}$. The results revealed the dependence of evaporation, condensation and water production on the surrounding air temperature. The results compared to the conventional system revealed in an increase of approx. 40% giving a yield of 7.08 $\text{l/m}^2/\text{day}$. The reported designed can be used to change the face of water desalination system throughout the world.

265

Novel design of PV integrated solar still for cogeneration of power and sustainable water using PV-T technology

Nikunj Usadadia, Mihir Lad, Sagar Paneliya, Sakshum Khanna, Abhijit Ray, Indrajit Mukhopadhyay*

Department of Solar Energy, Pandit Deendayal Petroleum University, Gujarat, India

*indrajit.m@sse.pdpu.ac.in

Clean water is considered to be the fundamental need of human survival. In this work we explore a novel approach towards desalination of brackish water using renewable energy. Compared to the

conventional solar still, the proposed work is an integrated system that uses solar energy to generate power and sustainable water. The proposed hybrid solar still is efficiently designed by integrating the concepts of both building integrated photovoltaic (BIPV) and solar thermal (PVT) technologies. A typical solar PV panel is around 15% efficient for turning solar irradiance into electricity, wasting the remaining energy in the form of heat. The motive is to use this low-grade waste heat in the most effective manner by having a tubing structure mounted on the rear side of the semi-transparent BIPV module leading towards an effectively pre-heated water up to 45°C-50°C with continuous water circulation at 380gm/min at the exit along with increasing the efficiency of the solar PV module by around 1% per day. A systematic investigation was performed to analyze system performance via multiple aspects such as distilled water yields, instantaneous and daily power production considering BIPV module. The results revealed that BIPV modules does not have significant effect on distilled water yield. However, it revealed that modifying the design of the condensing system along with using specially designed spiral heating collector (efficiency 56%) lead to increase of water yield. The maximum water production (4.9 litres/m² /day) is achieved for an integrated system of BIPV and solar thermal (PVT) technologies.

266

Cellulose Nanocrystals Incorporated Proton Exchange Membranes for Fuel Cell Application

Saleheen Bano^{1*}, Asif Ali¹, Sauraj¹ and Yuvraj Singh Negi¹

¹Department of Polymer and Process Engineering, Indian Institute of Technology Roorkee, Saharanpur Campus, Saharanpur, 247001, India.

*s.bano.24.2009@gmail.com

The present work deals with the study of proton exchange membrane prepared by employing cellulose nanocrystals (CNC) as novel, green, cost effective and sustainable nano-material as reinforcer into poly (ether ether ketone) based polymer matrix. The membranes were fabricated through solvent casting process and further evaluated by different techniques for their efficiency as suitable polymer electrolyte membrane for fuel cell. The presence of cellulose nanocrystals has profound effect on the membrane properties especially on proton conduction, a crucial feature determining the performance of fuel cell. A maximum value of 0.14 S/cm at 90 C under humid conditions was obtained for proton conductivity in the composite membranes with 4% CNC loading which is comparable to the conductivity achieved in similar conditions for Nafion.

267

Study of the effect of biomass derived N- self doped porous carbon in microbial fuel cell

Saswati Sarmah*, Minakshi Gohain and Dhanapati Deka

Tezpur University, Department of Energy, Tezpur 784028, Assam, India

*saswatisarmah22@gmail.com

Microbial fuel cell (MFC) has a great potential as a green and alternative form of energy. The main disadvantage of MFC is low power generation. The present work aims at developing biomass derived nitrogen self-doped porous carbon to be used in the cathode of MFC to increase its power output. Water Lettuce (*Pistia stratiotes*) underwent hydrothermal treatment along with pyrolysis at 700°C using CaCl₂ as the activating agent for the preparation of nitrogen self-doped porous carbon

(AWL). The BET surface area of the AWL was found to be 555.672 m²/g with mesoporous structure which was also confirmed with SEM image obtained of the AWL. XPS analysis showed that the nitrogen content of AWL was 3.64% along with the presence of graphitic, pyridinic and pyrrolic nitrogen. The presence of C-N and O-H group in AWL was detected by FTIR analysis. Dual chamber MFC was developed using kitchen waste as substrate in the anode chamber. AWL was coated in the stainless steel electrode and was then used as cathode. Open Circuit Voltage and power densities of MFC were recorded for a period of 10 days. A comparative study was also made of AWL coated electrode with plain electrode and also non-activated carbon (WL) coated electrode. MFC using AWL coated cathode exhibited maximum open circuit voltage of 696 mV along with the increase in power density by nearly 3 times.

268

IoT/AI based Smart Energy Management for Mushroom Farms

OaKInnovatica Solutions Private Limited

91Springboard, Creativity, Yerawada, Pune, India – 411006

info@oakinnovatica.com

www.oakinnovatica.com

The motive of this project was to achieve higher quality mushroom production with minimum energy expenses and maximum production yield. This project was divided into two parts; 1. Sensors, Controllers and IoT Gateway (All hardware and physical part) 2. Cloud server, ML/AI application, Dashboard and Alert Engine (All application and non-physical part) Sensors are placed at specific regions of the farm, which sense and record various parameters and give feedback to control units. Gateways are installed at a common place which communicate with controllers and server, and transact every minutes data in bi-directional mode. The control unit is setup with some basic parameters such as temperature, humidity and gas content that is required for the cultivation when the threshold varies, the control unit triggers the alarms and give instructions to the actuators and valves of HVAC system to regulate the fresh and chilled air in the growing room. An intelligent application installed on server analyses every minutes data and gives report to users about the health of crop. It also sends commands to controller to maintain favourable condition automatically. This intelligent application notifies users about the necessary action to be taken and also gives recommendations for better yield of crop.

269

Analysis of tilt angles and orientation for compound parabolic collector (CPC) for New Delhi

Aditi Garg^{*1}, Sanjeev Jain¹, Bahni Ray¹

1 Department of Mechanical Engineering, IIT Delhi, New Delhi, India

*aditigarg107@gmail.com

Compound parabolic collector (CPC) has the potential to harness the low to medium temperature range applications. It has an inherent advantage of collecting direct and diffuse solar radiation without diurnal tracking. However, an intermediate tracking or seasonal tilt change can further enhance the useful energy gain by the collector. These collectors are generally mounted in the East-West direction with the collector aperture plane facing south inclined from the ground at a tilt equal to the latitude of the place. In literature, some of the studies for North-South orientation of CPC have also been carried out. In this paper, analysis of orientation and tilt for CPC for New Delhi has been carried out using a previous studies and TRNSYS software. The optimum tilt angle has been derived for each

month and solar radiation received on the in-clined surface has been compared with tilt equal to latitude angle for all months. The process for obtaining optimum tilt and validation of the results have been done using previous studies. From the results obtained, it can be concluded that keeping the collector at optimum tilt angle can enhance both the solar radiation received and useful energy gain by the collector by 4-5%. The useful energy gain of cpc in E-W orientation has been found to be better than N-S by 5-7% in both cases of tilt angles. It can be recommended that for systems where high thermal efficiency is required, tilt angles can be changed monthly to maximize the outputs whereas for systems with financial limitations one can keep it at latitude angle.

270	Analysis of Nature Inspired Spirals for Design of Solar Tree
------------	---

Sumon Dey, Madan Kumar Lakshmanan and Bala Pesala*

Council of Scientific and Industrial Research- Central Electronics Engineering Research Centre, Chennai, 600113, India

*balapesala@gmail.com

The paper demonstrates the feasibility of using nature inspired spiral patterns in the design of solar tree. Analysis of properties of Fermat's spiral has shown that due to its uniform packing density, it is optimal for designing a solar tree with all solar panels of equal size. Further, solar panels with arithmetically increasing size may be used for the design of solar tree using Archimedes spiral. For a given set of spiral parameters, the size of the solar panels and the corresponding divergence angles have been optimized. The results show that >99% energy extraction efficiencies can be obtained using optimized solar panels dimensions at divergence angles 157.5° and 99.5° for Archimedes and Fermat's spiral respectively. It is observed that, for the same scaling factor and number of panels, the total projected ground footprint area is ~60 times higher in case of Archimedes spiral. Due to the higher packing fraction, Archimedes spiral based design offers higher energy density. However, Fermat's spiral based solar tree design provides higher energy density in cases where equal sized solar panels are used. Also, it is observed that, there are multiple divergence angles except the most commonly observed golden ratio (137.5°) that can offer optimal energy extraction.

273	Effective use of Existing Efficient Variable Frequency Drives (VFD) technology for HVAC systems – Consultative Research Case Studies
------------	---

Rahul Raju Dusa*, Atulkumar Auti and Vijay Mohan Rachabhattuni

Industrial Energy Group, The Energy and Resources Institute (TERI), Bangalore

*rahul.dusa@teri.res.in

The paper intends to illustrate our consultative research outcome on improving the use of already existing efficient Variable Frequency Drives (VFD) for the HVAC systems. The study highlights few noticeable operating practices which fail to capitalize the maximum benefits of such efficient technologies, via case studies on Water Cooled Screw Chillers and associated Cooling Towers. These assessments are further useful for centralized air conditioning system employed throughout the year in several industries and commercial spaces which poses significant challenge for effectively operating, reducing energy consumption and who are presently using or are planning to incorporate

energy efficient technologies such as VFD. It is aimed to help convey the entities to have a holistic approach while incorporating energy efficient measures and avoid overlooking fundamental operating conditions of the HVAC system. It was concluded that effective use of VFDs for chillers and cooling tower operations improve the chiller performance and coefficient of performance (COP) increases.

274

Dynamic Failure Assessment of the Liquid Ethylene Storage Unit

Prashant Srivastava^{1*}, Shishir Sinha²

¹Centre of Excellence in Disaster Mitigation & Management (CoEDMM),
Indian Institute of Technology Roorkee, Roorkee-247667, India

²Department of Chemical Engineering & CoEDMM,
Indian Institute of Technology Roorkee, Roorkee-247667, India

*prashant97iitr@gmail.com

Catastrophic accidents are formed in chemical process industries due to failure of equipment. Small and complex operations major reason to form the different level of hazards (e.g. environmental, economic and social). Dynamic failure assessment is depended upon the failure probabilities of basic events and safety barriers of the system which are involved during different process operations. In this paper, a Bayesian approach has been helpful to examine the dynamic failure assessment of liquid ethylene storage unit. Leakage of ethylene from the storage unit was the primary abnormal event which can be formed different consequences due to failure of the safety systems. So the dynamic failure assessment of the storage unit has been done by the help of accident sequence precursors (ASP) data. Bayesian approach has been used to estimate the different possible outcomes of the process failure. This methodology showed the importance of the safety barriers for taking the decision making to minimize/prevent the failure of the processing system, and also showed the attention on the failure part of the system to enhance the safety features. In addition, this approach provided an opportunity to change the failure probability data with actual plant data for real assessment.

275

Thermodynamic Analysis of a Combined Power and Cooling System Integrated with CO₂ Capture Unit of a 500MWe SupC Coal-fired Power Plant

Rajesh Kumar, Goutam Khankari, Sujit Karmakar*

Department of Mechanical Engineering, NIT Durgapur, West Bengal-713209, India

*sujitkarmakar@yahoo.com

The present paper proposes a Combined Power and Cooling System (CPCS) driven by solar energy and low graded heat sources released from the CO₂ compression and flue gas condensation systems in a 500MWe Supercritical (SupC) coal power plant with MEA based CO₂ Capture Unit (CCU). The proposed system is modeled in computer-based modeling software 'Cycle-Tempo' at different operating conditions. The results show that the energy and exergy efficiencies of the plant can be increased by about 4.23 % and 3.90 % points, respectively over the 500MW standalone plant with CCU due to additional net electric power of about 30.68 MW using solar-assisted CPCS at full load. Additional electric power helps in the reduction of auxiliary power requirement for the CO₂ capture

system by about 58.42 % in a 500MWe SupC coal power plant. Additional cooling effect of about 52.57 MW can also be obtained from the proposed system at full load. The net energy and exergy efficiencies of the solar- assisted CPCS are about 22.79 % and 38.47 %, respectively at full load and its variation at different operating conditions are also analysed. The proposed system reduces coal requirement by about 22 t/h at full load, and about 29.29 t/h of CO₂ emission can also be avoided for the 500 MWe SupC steam plant without CO₂ capture due to low scheduled generation. Economic analysis also shows that the Levelized Cost of Electricity (LCoE) generation and Simple Payback Period (SPP) of the proposed plant is about Rs.3.50/- per kWh and 5.42 years, respectively.

277

DFT studies on electronic and optical properties of inorganic CsPbI₃ perovskite absorber for solar cell application

Abhijeet Kale, Rajneesh Chaurasiya and Ambesh Dixit*

Department of Physics, Indian Institute of Technology, Jodhpur, 342037 India.

*ambesh@iitj.ac.in

We computed electronic and optical properties of inorganic cubic perovskite CsPbI₃ absorber using Perdew-Burke-Ernzerhof (PBE) with Generalized Gradient Approximation (GGA) and modified Becke-Johnson (mBJ) exchange-correlation potential. The optimized lattice parameter is 6.3772 Å and the computed direct band gap values at high symmetry point-R are 1.42 and 1.72 eV for GGA-PBE and mBJ exchange correlation potential, respectively. Electronic as well as optical properties are investigated by computing projected density of states (PDOS), dielectric function, refractive index, extinction coefficients, reflectivity and absorption as a function of energy. The large absorption coefficient of CsPbI₃ is making it a promising absorber for photovoltaic applications.

278

Biowaste Derived Highly Porous Carbon for Energy Storage

Dinesh J. Ahirrao, Shreerang D. Datar and Neetu Jha*

Institute of chemical technology, Matunga (E), Mumbai (MH), India

*nr.jha@ictmumbai.edu.in

The demand for activated carbon (AC) is incessantly growing with population, due to its wide spread applications in wastewater treatment, air purification, hydrogen storage, gas separation and energy storage devices, but the complicated fabrication procedures, necessity of sophisticated instruments and requirement of expensive precursors restricts its use. In this article, extremely porous activated carbon has been prepared from waste sweet lime peels (Citrus limetta). KOH solution was used as an activator because of its low activation temperature and high product yield. Carbonization was performed at 500 °C. The structural and morphological properties of as prepared porous carbon were investigated by X-ray diffraction (XRD), Raman spectroscopy and scanning electron microscopy (SEM). Electrochemical characterizations such as cyclic voltammetry (CV), Galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS) were carried out at different scan rates and current densities in an aqueous electrolyte (1M H₂SO₄). The GCD for activated carbon electrodes resulted in superior electrochemical performance with a high specific capacitance of about 243 F/g at 1 A/g. The activated carbon also showed excellent cyclic stability over 5000 charge-

discharge cycles without any reduction in its initial capacitance. This shows the excellent performance of sweet lime peels AC as a stable and inexpensive material for energy storage applications.

279

Bio-ethanol production from carbohydrate-rich microalgal biomass: *Scenedesmus obliquus*

Maskura Hasin*, Minakshi Gohain and Dhanapati Deka

Biomass Conversion Laboratory, Department of Energy, Tezpur University

*maskurahasin@gmail.com

Microalgae are considered as a promising and inexpensive feedstock for biofuel production by microbial fermentation. Algal based fuels are renewable, effective and environment friendly as they have the potential to match the global demand for fuel in the future. The pre-treatment and carbohydrate extraction from algal cell are the main obstacle in the bio-ethanol production step. Hence, the present study aimed to evaluate the potential of using *Scenedesmus obliquus* (SO), a carbohydrate-rich microalgae species as feedstock for bio-ethanol production via various pre-treatment techniques. Herein, simultaneous hydrolysis and fermentation process was carried out followed by distillation. *Saccharomyces cerevisiae* was used as fermentative microorganism. Various characterizations of the raw sample such as proximate analysis, gravimetric analysis, FTIR was performed to test the suitability of SO for bio-ethanol production. The cellulose content of the raw SO was found to be 53.08% which proves its suitability for production of bio-ethanol. Bio-ethanol formation was confirmed by gas chromatography.

280

Safety Analysis of Loss of NPP off-site power with failure of Reactor SCRAM (ATWS) for VVER-1000

Manish Mehta, Sanuj Chaudhary, Anirban Biswangri, P. Krishna Kumar, Y.K.Pandey, Gautam Biswas

Nuclear Power Corporation of India Ltd, Mumbai, 400094

Loss of off-site power in the Nuclear Power Plant (NPP) with failure of reactor SCRAM i.e inability to automatically drop control rods into the core after reactor trip signal during transient for PWR, is considered as a Design Extension Condition (DEC). Such event is called as ATWS i.e. Anticipated Transient Without Scram. The event has been analyzed using Thermal Hydraulic computer code RELAP-5/MOD 3.2 for Kudankulam Nuclear Power Plant (KKNPP). RELAP-5/MOD 3.2 uses a one-dimensional, two fluids, non-equilibrium, six equation hydrodynamic model with a simplified capability to treat multi-dimensional flows. KKNPP has two operating VVER-1000 Reactors. VVER-1000 is a Pressurized Water Reactor having active and passive safety systems for such event mitigation. As a result of the initiating event i.e Loss of NPP station service power, trip of reactor cool- ant pump, closure of turbine governor valve and loss of steam generator feed water takes place. This affects heat removal from the reactor core due to loss of coolant circulation and pressurization of the primary and secondary circuit due to closure of turbine governor valve. This results in generation of reactor scram signal. Failure of reactor SCRAM is considered in the event. Thus, the reactor power is not decreased even after the scram signal and ATWS condition is identified. This

results in actuation of both passive and active safety system for boron addition in to the core, designed for ATWS mitigation. The objective of this study is to evaluate the thermal hydraulic and neutronic behavior of the core and verify the capability of safety systems for event mitigation. The thermal hydraulic parameters are checked against the applicable acceptance criterion for the event.

281	Orifice Enabled Flow Stabilization of Natural Circulation Loop at Lower Inclinations
------------	---

Adarsh R Nair, Rupesh S*, Raveesh G, Abhijith Nair A S

Mar Baselios College of Engineering and Technology, Mar Ivanios Vidyanagar, Thiruvananthapuram, Kerala

*mailto:rupeshs@gmail.com

Natural circulation loop (NCL) is mainly used as passive cooling system in nuclear power plants to ensure safety during pump failure and station blackout. Stable operation without flow instability is the most desirable operational mode of natural circulation loop for passive cooling. The present work deals with numerical analysis on the effect of inclination of horizontal leg of a rectangular loop working in single phase and presence of orifice on the thermo-hydraulic behavior of NCL, using commercial CFD code ANSYS FLUENT 19. The effect of temporal variation of loop mass flow rate and temperature difference across the cooler section is compared for inclined loop with and without orifice. It is observed that the flow stability attained in the loop at $\theta=30^\circ$ can be achieved at $\theta=10^\circ$ with orifice, with a reduction in the loop mass flow rate of 32.03%. The reduction in loop mass flow rate is accompanied by an increase in temperature difference across the cooler of 62.21%.

282	Load frequency control of two interconnected area microgrid system using various optimizations for the robust controller
------------	---

Deepak Kumar Soni¹ and Dr. Prakash Dwivedi²

¹ Electrical Department, NIT Uttarakhand, India
deepakkumar.soni.eee17@nituk.ac.in

² Electrical Department, NIT Uttarakhand, India
prakashdwivedi@nituk.ac.in

In this paper, a robust load frequency controller is investigated for a two interconnected area hybrid microgrid system (HμGS). Genetic algorithm (GA) and particle swarm optimization (PSO) is applied to find parameters of proportional-integral-derivative (PID) controller. The robustness of the proposed controller demonstrated for various disturbance including wind speed variation, load perturbation, and sun irradiance variation. Wind-turbine-generator (WTG) and photo-voltaic array (PV) are subjected to maximum power point tracking method therefore, they do not participate in load frequency regulation.

283	Dust explosion : A Review
-----	----------------------------------

Vignesh Shenoy¹, Nilesh Sakpal², Akshay Agwan² and Samarth Patwardhan¹

¹ School of Petroleum, MITWPU, Pune

² Techniche Engg. Pvt, Ltd., Pune

Dust explosion, one of the most serious and wide spread explosion hazards, which is recently a topic of main concern for the developed countries are not even identified as a serious threat in developing countries. In this paper we present a review on the concept of dust explosion, by critically reviewing the work done in this domain, a brief on the equipment used for studying this field, followed by possible directions this research could be furthered in.

284	Voltage Regulation Distribution Systems with Capacitors and OLTC in Presence of PV Penetration under Uncertain Environment
-----	---

VVSN Murty* and Ashwani Kumar

NIT Kurukshetra, Haryana, India

*murty209@gmail.com

Optimal reactive power management is one of the key operational aspects for efficient utilization of the network. More voltage deviation and energy loss are major issues in distribution system due to lack of co-ordination among reactive power sources and voltage control devices. This study has become more challenging with renewable sources integration in the network. In this paper, a hybrid optimization model is proposed for optimal reactive power compensation in reconfigured distribution systems with PV penetration. The main contributions of the proposed work are: (i) Capacitor allocation using Ant Lion Optimization (ALO), (ii) capacitor rating determination using General Algebraic Modeling System (GAMS), (iii) reconfiguration of distribution system using genetic algorithm, (iv) impact of load uncertainty on reactive power compensation, (v) reactive power dispatch considering co-ordination among capacitors, OLTC with PV penetration. The proposed methodology is tested on IEEE 33-bus test system.

285	P-type Crystalline Silicon Surface Passivation using Silicon Oxynitride/SiN Stack for PERC Solar Cell Application
-----	--

Irfan M Khorakiwala*, Vikas Nandal, Pradeep Nair and Aldrin Antony

Department of Electrical Engineering, Indian Institute of Technology Bombay, Powai, Mumbai, Maharashtra-400076

*imkhorakiwala@iitb.ac.in

Silicon nitride layers have been long used as front side passivation layers for n-type silicon substrates. Here we explore the passivation property of silicon oxynitride (SiON) and silicon oxynitride/silicon nitride stacks, instead of SiO₂, on p-type silicon wafers for back-surface

passivation. SiON and SiON/SiN stacks can be deposited at low temperatures with very high deposition rates compared to SiO₂. Since SiN and SiON form an inversion layer at the interface when contacted with p-type silicon, these dielectric layers are not ideal for passivating p-type substrates but the commercial benefits of these dielectric layers in terms of low thermal budget and high deposition rates motivated us to look deeper into the passivation properties of these dielectric layers by using Capacitance-Voltage and carrier lifetime measurements. Different types of charges like fixed charge, mobile charge and interface charge have been calculated using “MOS-capacitor” like structures with SiON and SiON/SiN stack as insulating layers. These results indicate that the interface charge dictates the passivation quality of these dielectric layers.

286	Pressure Propagation and Flow Restart in the Subsea Pipeline Network
------------	---

Lomesh Tikariha* and Lalit Kumar

Indian Institute of Technology, Bombay, India – 400076

*lomesh.02@gmail.com

Waxy crude oil transportation at cold sub-sea condition encounters a severe flow assurance problem. Occasional maintenance and emergency shutdown requirement of the crude oil pipeline may profound gelation process. The gelation of crude oil may result-in pipeline blockage. In order to restart flow in a gelled pipeline a high axial pressure gradient is applied, across the gel plug, to breakdown the gel structure. During shut-down, waxy crude gelation leads to shrinkage in the gel structure as seen in dead oil (gas desaturated oil) and subsequently, releases free gases. Free gases results in void formation and a multi-plugged gel in the industrial pipeline. The gel separated by gas pocket is termed as multi-plugged gel, which may form due to uneven earth surface, especially on sea-bed. In this work, flow restart in multi-plug gelled pipeline is investigated by solving mass and momentum balance equations together with strain-dependent rheological equation. The Volume of Fluid (VOF) method is utilized to distinguish bulk phases and the advection equation of volume fraction traces the motion of gel-gas interface. The time evolution of applied pressure propagation in the gelled pipeline has been compared with earlier works. It shows that the present profile exactly matches with the pressure profile in the single- phase flow before it encounters the gas pocket. The effect of multi-plug in restart operation may result in early gel degradation and flow restart. The result obtained in this work can be used to reduce the margin of safety commonly adopted due to overestimated pressure requirement.

288	Electrodeposition of Cu₂O: Determination of limiting potential towards solar water splitting
------------	--

Iqra Reyaz Hamdani and Ashok N. Bhaskarwar*

Indian Institute of Technology Delhi, New Delhi, India - 110016

*ashoknbhaskarwar@yahoo.co.in

This work demonstrates a detailed case study on the electrodeposition of p- Cu₂O onto FTO substrates. Cu₂O thin films were prepared at different potentials ranging from -0.2 V to -0.6 V vs Ag/AgCl. Structural, morphological, optical, and photoelectrochemical properties were investigated

by X-ray diffraction, scanning electron microscope, UV-Vis spectrophotometer, and Autolab PGstat, and the performances were measured and compared at each potential. It was observed from the electrochemical studies that for the electrodeposition of Cu₂O, there exists a limiting potential, at which the generation of photocurrent density is maximum. The impedance studies, film thicknesses, and XRD analysis, together implied the potential of -0.4 V to be the limiting potential in this work.

290

Efficient Waste Water Vaporizer using Rotating Contacting Device

Milind V Rane^{1*}, Aditya M Rane¹ and Ajay Tandon²

¹ Heat Pump Laboratory at Indian Institute of Technology Bombay, Powai, Mumbai, MH 400076, India

² FAM Technologies Pvt Ltd, Vadodara, GJ 390005, India

*ranemv@iitb.ac.in

Domestic, commercial, industrial or agricultural activities often generate wastewater. At a global level, around 80% of wastewater produced is discharged into the environment untreated, causing widespread water pollution. In India government is encouraging industries to treat their effluents within the waste water generators premises. Industrial units are encouraged to achieve zero liquid discharge (ZLD). Often industrial wastewater contains salts and effluent may be acidic or alkaline. Depending upon the availability of fresh water, its cost, and interest in recovering the salts or chemicals and or water out of the effluents there might be different processes employed for treating the effluents. There are various types of wastewater vaporizers, first type is electrical evaporators in which forced circulation, falling film and heat pump are used to vaporize water from the waste water. Second type is electrically powered crystallizers are used integrated with heat pump with single or multi-effect evaporation, equipped with density induced or forced circulation mechanisms. Third is thermal crystallizers. The paper will present a novel modular maintenance friendly energy efficiently wastewater vaporizer that can be deployed for concentrating industrial effluents and/or crystallizing salt/s by judiciously tapping the availability in ambient air. The Specific Moisture Removal Rate (SMER) value of the WWV_RCD was 30 to 42 kg/kWh, while vaporizing industrial effluents which have been pre-concentrated using reverse osmosis process.

293

Life Cycle Assessment for Eco-efficient brick selection

Sushibala Nambram¹

¹Centre for Urban Science and Engineering, Indian Institute of Technology, Bombay, India

The focus of building material selection research is shifting from the reduction of operational energy in use phase to reduction of environmental im-pact in the overall life cycle of a building. This study investigates the environ-mental impact of the construction of a building by applying “Cradle to Gate” life cycle assessment. It further investigates the change in environmental impact by substitution of conventional brick by sand-lime brick. Among the building mate-rial, concrete cause maximum impact followed by steel reinforcement bars and then brick. Substituting conventional brick by sand-lime brick resulted in a reduction of overall impact score by 10 per cent.

294	Design and development of an economical and reliable Solar Powered Trash Compactor
------------	---

Ridhi Lakhotia, Abu Fazal, Ajay Yadav, and Ankur Bhattacharjee*

Birla Institute of Technology and Science Pilani, Hyderabad campus, Telangana, India

*a.bhattacharjee@hyderabad.bits-pilani.ac.in

In this paper, a reliable and economical solar-powered trash compactor has been developed and demonstrated. This increases the capacity of existing trash bins by 5-8 times per day, depending on the equipment used. An important advantage of this waste compaction mechanism is integrating solar PV source with the existing trash compactors thereby improving its operation flexible and economically viable. Considering the intermittency of solar PV source, battery storage is also integrated with the system to ensure the power supply reliability. In this paper, a maximum power point tracking (MPPT) based charging topology is used to transfer the maximum power from the solar PV to the battery and thus to enhance the power conversion efficiency of the power electronic interface. As prolonged monsoons can disrupt the compaction process due to the unavailability of solar PV source, therefore grid integration with the proposed system ensures the long term continuity of operation. Moreover, surplus solar energy is exported to the grid, thereby cutting down the electricity tariff significantly. A prototype of the solar-powered trash compactor system with one time garbage compaction capacity of 2.5lbs has been developed to validate the proposed topology to be applicable for large capacity trash compactors as well.

296	Techno-economic analysis of solar trigeneration system based on two stage humidification-dehumidification desalination and concentrated photovoltaic/thermal collector
------------	---

B.Anand*, S.Murugavelh and R.Shankar

CO₂ Research and Green Technologies Centre, Vellore Institute of Technology, Vellore, India

*anandgbea@gmail.com

In this work, techno-economic analysis solar tri-generation for power, desalination and cooling is presented. The plant comprises of a Concentrated Photovoltaic/Thermal (CPVT) collector, a two stage humidification- dehumidification (HDH) desalination unit, a compressor operated chiller unit. The Concentrated Photovoltaic/Thermal collector is a type of photovoltaic/thermal technology that generates electrical power and hot water simultaneously from high intensity solar radiation focused by lenses and curved mirrors. The collector having 20 m² aperture area and a triple junction solar panel at the receiver supplies required hot saline water to the humidification- dehumidification desalination unit. The compressor operated chiller unit supplies chilled water to the second stage of desalination system. Cooling and dehumidification of humid air using chilled water increases desalination yield and resulting air is at low temperature suitable for air conditioning. The work is aimed to evaluate annual performance of the plant and to estimate the unit cost of desalinated water. The overall plant performance is analyzed in terms of energy utilization factor (EUF). The developed model is validated with experimental work. The annual plant performance is analyzed for the Typical Meteorological Year (TMY) data of Vellore, India having 12.9165° N, 79.1325° E. Results show that the annual desalination, electricity and cooling output are 23.39 m³ /year, 7.19 MWh/year and 1.03 kWh/year respectively. Considering the energy cost (₹ 6.5/kWh), interest rate

(9 %) and life time of the project (30 years), the cost of desalinated water with and without subsidy is estimated to be ₹ 1.18/L and 1.51/L respectively. The highest plant EUF of 0.495 is achieved in the month of highest solar radiation.

298

Performance and Emission Characteristics of CI Engine Fuelled With Plastic Oil blended with Jatropha Oil and Diesel

Babu S and Kavin K*

PSG college of Technology, Coimbatore, Tamil Nadu, India

*kavin.k00@yahoo.com

This work is to present the results of the Performance and Emission of Compression Ignition (CI) engine fueled with Waste Plastic Py- rolysis Oil (WPPO) and Jatropha Methyl Ester (JME) blended with Diesel. Two different blends (20% and 40%) varying WPPO, JME and Diesel proportions were experimented in the CI engine whose compression ratio was 17.5:1. CI engine is most used engine in both power and transport sector, but rapid consumption of conventional fuels results in increase of fuel price as well as environmental pollution due to the release of exhaust gases. In order to reduce both pollution and cost of fuel, we need an alternative fuel. Jatropha is chosen as one of the fuel due its non-edibility and larger source found in India. WPPO is chosen as another fuel in order to reduce the waste deposit and also to utilize the energy from waste.

299

Corrosion Analysis of CI Engine Components by using Dual Blend of Biodiesel

K.P Shredha Manoj¹ , Anurag Mishra¹ , Albin K Saji¹ , Manoj Chaudhari¹ , Sajan K Chourasia^{2*}

¹Mechanical Engineering Department, Gandhinagar Institute of Technology, Gandhinagar, India

²Mechanical Engineering Department, Gandhinagar Institute of Technology, Gandhinagar, India.

*sajanlchourasia@gmail.com

As the increasing crisis for fossil fuel the demand of biodiesel has increased immensely, but as for now the allowable blends for biodiesel and diesel is 20% and 80% respectively, because of the increase in biodiesel causes corrosion in the components degrading the life of the engine. The aim of this work is to investigate the effects of biodiesel on the materials of the components of CI engine by the analysis of corrosion test on these materials. This immersion test of various dual blends of biodiesels and diesels was carried out under 20°C to 30°C temperature for 150 days. By the end of 150 days the corrosion properties were analyzed by weight loss measurements and contact surface changes on the coin. The fuels were analyzed by GC-MS to investigate the component at a molecular level of biodiesel (i.e. castor, rapeseed, neem oil). Bio-diesel consists of saturated and unsaturated fatty acids esters which enhances its property of corrosion in metals. The material selection for immersion was based on the fuel contacting components of a CI engine.

300

Performance Analysis of Hybrid Photovoltaic Array Configurations under Randomly Distributed Shading Patterns**Vandana Jha***

Department of Electrical Engineering, C.V. Raman College of Engineering, Bhubaneswar, 752054, India

*vandanajha.electrical@gmail.com

The aim of this paper is to study the performances of hybrid photo-voltaic (PV) array configurations under randomly distributed shading patterns. The hybrid PV array configurations considered in this paper: , Series Parallel- Total Cross Tied (SPTCT), Bridge Linked- Total Cross Tied (BLTCT), Honey Comb- Total Cross Tied (HCTCT) and Bridge Linked- Honey Comb (BLHC) have been derived from the classical configurations. The analysis has been carried out by comparing the performances of these PV array configurations justified by the values of their maximum powers, fill-factors, thermal voltages and relative power losses for five randomly distributed shading patterns. Moreover, one realistic shading pattern has also been developed for practical investigation of the performances of hybrid PV array configurations. The complete research has been done on PV arrays of size , made of HIT-N240SE10 PV modules. The of hybrid PV array configurations obtained for six randomly distributed shading patterns have been examined by Cumulative Distribution Function to forecast regarding the order of the performances of hybrid PV array configurations under .

301

Energy audit for thermal and electrical energy conservation at corrugated paper boxes manufacturing plant at MIDC Sinnar, Nashik**Hitesh R. Thakare^{1*}, Trilokinath Agrawal²**¹BEE Certified Energy Auditor (EA – 27707) and Assistant Professor, SNJB's Late Sau. K. B. Jain College of Engineering, Chandwad, Dist. Nashik – 423 101²BEE Accredited Energy Auditor, T. N. Agrawal & Co. Ltd., Nashik

*thakare.hitesh@gmail.com

With the ever increasing concerns of global warming, ozone layer depletion as well as exhaustion of fossil fuel reserves worldwide, it has become necessary to utilize the existing energy sources in an efficient way. Energy audit is a quantitative analysis of energy usage of an industrial facility that enables the user to identify and quantify the areas in which energy losses are taking place. Present study is concerned with field work carried out to conduct energy audit of corrugated paper boxes manufacturing plant. Systematic energy audit methodology prescribed by Bureau of Energy Efficiency has been followed for field work. Results indicate that there is significant potential for energy saving even in case of small scale manufacturing plants. Savings were mainly observed in case of application of insulation as well as power factor improvement. Energy audit calculations indicate potential annual saving of Rs. 54,815/- . This potential saving constitutes 12.20% of annual electricity bill of this industrial facility.

302

Flow Improvement Aspect with Stagger Angle Variation of the Subsequent Rotor in Contra- rotating Axial Flow Turbine**Rayapati Subbarao***

Department of Mechanical Engineering, NITTTR, Kolkata

*rsubbarao@nittrkol.ac.in

Flow in an axial flow turbine stage is complex due to the presence of different types of blade rows, gap between them, tip clearance provided and twisting of blades. This flow aspect may change, if the parameters like speed, gap and blade angles are changed. Current work contains computational study of the flow aspect of contra-rotating axial flow turbine stage with different stagger angles of second rotor, ranging from 8 to 13°. Mass flow rates are varied from 3 to 4.5 kg/s. Stage constituents, stator, rotor 1 (R1) and rotor 2 (R2) are modeled for all the cases of staggering, considering an axial gap of 30% of the axial chord between the blade rows. At stator inlet, total pressure and at stage outlet, mass flow rate are identified as boundary conditions. Skin friction lines on rotors, flow, deviation angles and velocity contours are used to study the flow physics. Not much variation of skin friction lines is observed in case of R1 on the pressure side. Skin friction lines on the pressure side of R2 show re-attachment lines and nodes. For the same region in R1, there is proper re-attachment, as nodes are observed instead of lines, suggesting that more improved flow is occurring in R1 than R2. This aspect is reduced with

staggering. Also, effort is made to capture the flow aspect in the second rotor, measuring incidence angle and drawing velocity contours. incidence angle is less and flow is better in case of S10. Thus, staggering of second rotor showing beneficial effect.

303

Performance Assessment of Pelton Turbine with Traditional and Novel Hooped Runner by Experimental Investigation**Vimal K. Patel*¹, Hemal N. Lakdawala², Sureel Dohare³, Gaurang Chaudhary⁴**¹ Assistant professor, SVNIT, Surat, Gujarat, India² Assistant professor, Govt. Engg. College, Valsad, Gujarat, India³ Research scholar, SVNIT, Surat, Gujarat, India⁴ Assistant professor, CKPET, Surat, Gujarat, India

*vimal.iitbombay@gmail.com

Hydro turbomachines are used since long as a water wheel, even before knowledge of fluid mechanics. A newly developed concept at runner i.e. hooped is considered here for investigation purpose. This paper mainly focuses on the performance comparison between traditional and hooped type Pelton wheel turbine runner. The performance characteristic of any hydraulic machines describes the behavior of the machine under operating conditions. The downcomer jet impingement to the rotor buckets provides more velocity and thereby impulse to a runner. Efficient performance behavior of any turbo machine under consideration can be easily estimated from performance curves for that machine under specified conditions. In case of impulse type machines, it relies on the quality of jet and other

aspects of jet-vane interaction too. In the present investigation, the performance of two types of runner has experimented on the same setup and flow conditions. The main objective of this paper is to compare the performance of a regular runner with a novel hooped runner. It has been found that hooped runner exhibits same characteristics with some loss of efficiency due to overweight and loss of energy at buckets due to restricted passage created by a hoop (flanges) but on contrary, the reliability and safety of buckets can be ensured. In additions, less deflection of the bucket can also be ensured under heavy jet force.

304	Optimal generator side bidding with carbon emission trading and RESS
------------	---

Anoop Arya^{1*}, Somendra P.S. Mathur² and Manisha Dubey³

1, 2, 3 Electrical Engineering Department Maulana Azad National Institute of Technology, Bhopal

*anooparya.nitb@gmail.com

As a major Green House Gases (GHG) producer, CO₂ in particular, the electricity industry's emissions have turned in to a matter of immense concern in many countries, especially in India. India's economy and fast economic development has attracts the attention of the world. Two main schemes i.e CO₂ emission trading and renewable support schemes (RESS) are executed by the various developed countries to alleviate the affect of GHG emissions. In this work, an optimization based market simulation methodology is implemented with examine the impact of CO₂ emission trading and renewable support schemes on electricity market operation. To simulate the bidding strategy and for profit maximization, an optimization method is used. As above problem is a multi-objective optimization problem, where at the starting each GenCo must submit a bid to the independent system operator and then, an optimization method will be used for the profit maximization. It is assumed that each generator should submit bid in sealed auction based on pay-as-bid MCP (market clearing price) mechanism with knowing the rival's bidding behavior. The practicability of proposed optimization method is examined by an IEEE-30 bus system which consists of six suppliers.

305	Evaluation of LVRT Control Strategies for Offshore Wind Farms
------------	--

M. M. Kabsha^{1, 2*}, Zakir Rather*¹

¹ Indian Institute of Technology, Bombay, India-400076, India

² Mansoura University, Mansoura, Egypt-35516, Egypt

*m.kabsha@iitb.ac.in, zakir.rather@iitb.ac.in

The penetration of Offshore Wind Farms (OWF) connected to the electric utility grid through voltage source converter-based high voltage DC (VSC- HVDC) increased year by year in some countries. However, penetration of HVDC connected OWF affects electric power system voltage and frequency stability during a grid disturbance, which enforces system regulators to update their grid code regulations for secure and stable operation. Low Voltage Ride Through capability (LVRT) for OWF ensures that OWF stays grid connected during a voltage disturbance, and support the electric grid during such low voltage fault events instead of direct tripping. Several LVRT strategies for HVDC connected OWF are reported in the literature, however, without considering a critical factor of active power recovery (APR)

ramp rate requirements. In this paper, three LVRT strategies have been investigated to comply LVRT and APR requirements. The different LVRT strategies for OWF considered in this study were tested under different scenarios in IEEE 39 bus benchmark system, and a comparative analysis of these LVRT strategies have been reported in this paper.

306	Thermochemical conversion of tomato plant waste for liquid fuel production
------------	---

K. Midhun Prasad¹, S. Murugavelh^{2*}

¹ School of Mechanical Engineering

² CO 2 Research and Green Technologies Centre, Vellore Institute of Technology, Vellore, India

*murugavelh.s@vit.ac.in

Pyrolysis is the technology used for thermal conversion of solid biomass into liquid bio oil and other chemicals. Objective of the work is to characterize the bio oil obtained. The quality of the bio oil produce is directly proportional to the type of the biomass. Fast pyrolysis of tomato plant waste residue is carried out in an auger reactor at the operation temperature range from 450 °C to 650 °C, initial sample mass of 3 kg, with the particle size of 2 mm to optimize the temperature for higher oil yield. At the heating rate of 20 °C with the residence time of ≈ 2 min. The vapour produced is condensed by passing into the condensing column. Biomass sample is subjected to pre-treatment and the oil obtained is analysed with calorific value, GC-MS and FTIR. Calorific value of the oil obtained was found high. This study is to find the convert the waste into high energy content liquid fuel.

307	An Experimental and CFD analysis on Heat Transfer and fluid flow characteristics of a tube equipped with X-shaped tape insert in a U-shaped heat exchanger
------------	---

Sagar Paneliya¹, Sakshum Khanna¹, Jeet Mehta¹, Vishal Kathiriya¹, Umang Patel², Parth Prajapati³, Indrajit Mukhopdhyay^{1*}

¹ Department of Solar Energy, Pandit Deendayal Petroleum University, Gujarat

² Department of Mechanical Engineering, SVBIT, Vasan, Gujarat, India

³ Department of Mechanical Engineering, Pandit Deendayal Petroleum University, Gujarat

*Indrajit.m@sse.pdpu.ac.in

In this paper, the performance of a heat exchanger equipped with X-shaped tape insert was investigated and reported. Experimental investigation was performed to calculate overall heat transfer coefficient, effectiveness, friction factor and pressure drop of the fluid flowing through U-tube fitted with X-shaped tape insert. Mild steel was used to manufacture X-shaped tape insert due to the ease of availability and machineability. Two X-shaped tape insert of 1 m length each were incorporated in the U-shaped tube of length 2.4 m. Resistance thermometers were employed to measure the temperature of the working fluid at the inlet and the outlet of the test section. It was evident that the turbulence ($Re > 4000$) created by the X-shaped tape insert in the fluid, enhanced the heat transfer of the system. The results showed that the heat transfer rate and overall heat transfer coefficient of U-shaped tube fitted with X-shaped tape insert were 2.5 times and 3.15 times respectively than the U-shaped tube without the insert. The experimental data were substantiated using the Computational Fluid

Dynamics (CFD) simulations. The simulated results supported the experimental results with an error ranging from 2-5%.

308

Single particle analysis of thermally thick wood particles in O₂,N₂ [(,CO)]₂ atmosphere

Shruti Vikram^{a*} , Sandeep Kumar^b

a,b Department of Energy Science and Engineering, IIT Bombay, 400076, India

*shrutivikram28@gmail.com

In this era of shortages of non-renewable energy resources and rapid price hike, biomass gasification is re-emerged as an efficient option for energy production which can convert 60-90% of biomass energy into product gas which can be used either in heat generation or electricity production. Pyrolysis and char conversion are two major processes that finally lead to overall biomass conversion to fuel gas. Extensive work is available for volatile combustion model and char reduction model, however, very limited work has been proposed for pyrolysis model. Also, very few literature is available for thermally thick particles in modeling work. The existing pyrolysis models are adopted from inert pyrolysis or flaming pyrolysis in presence of air. Therefore, research needs to be conducted using various reactants apart from air like, oxy-steam etc. The present study focuses on the experimental evaluation of pyrolysis rate and char conversion rate of single biomass particle under similar conditions in packed bed gasification. The pyrolysis and char conversion rates were then analyzed from the view of various factors such as varying gas flows, shape and density of biomass at fixed mass flux of inlet stream. The mass loss characteristics for each case were used as the tool for analysis and it was studied by fabricating the single particle reactor. NASA SP 273 code was used for getting equilibrium concentration of various species in gas stream and the adiabatic Temperature.

309

Design and Analysis of a Hybrid Energy System for Improving Urban Energy Potential

Deepak Kumar¹ , Tavishi Tewary² , and Sulochana Shekhar³

^{1,2} AMITY University, Sector 125, Noida – 201303, Uttar Pradesh, India.

³ Central University of Tamil Nadu (CUTN), Neelakudy, Tamil Nadu-610005, India. deepakdeo2003@gmail.com, dkumar12@amity.edu

Scientific and industrial development has given escalation to a rapidly increasing energy demand. Alternative and augmented sources of energy, are being sought everywhere due to the depletion of other non-renewable resources. Solar and wind energy have emerged as one of the cleaner energy sources offering a promising solution to typical polluting energy resources with better efficiency. Hence, the attention has now shifted towards the large-scale propagation of hybrid renewable energy system. Numerous attempts have been taken to illustrate the technological advancement considering the requirement of the particular region. Whilst some research has begun to examine the functionality and assessment of hybrid energy systems but little attention has been paid towards the contribution of the hybrid

energy system for urban areas. The proposed work also focuses on the simulation of the hybrid renewable energy systems with respect to techno-economic feasibility. This work also reports the various technological, scientific and industrial growths occurred in the area of the hybrid renewable energy system. This paper tries to showcase the modelling of a typical urban setup to determine the hourly load profile. The study identifies the growths in the energy potentials of the urban region with the use of hybrid energy system. It also summarizes the past, present and future trends of the hybrid energy system design, development and implementation for the urban region, which can be used in the other parts of the world.

310	An Analysis for Management of End-of-Life Solar PV in India
------------	--

Snehalata Pankadan^{1*}, Swapnil Nikam¹⁺, Naqui Anwer^{1#}

¹ TERI School of Advanced Studies, New Delhi, India

*snehalata.pankadan@terisas.ac.in, +swapnil.nikam@terisas.ac.in, #naqui.anwer@terisas.ac.in

Climate change and depleting energy resources have led the world to adopt new energy resources. Over the years, renewable energy sources and the associated technologies have witnessed a giant progress towards sustainable development. Solar Photovoltaic (PV) systems are the global as well as Indian flag bearers of renewable energy. Solar panels contain hazardous but valuable materials, which gives an opportunity to be recycled and reused. A proper waste management strategy can tackle the PV waste generation as well as reclaim required materials from it rather than being discarded in the landfills which can raise environmental concerns. India being the second most populated country relies more on conventional sources. The demand for electricity has grown exponentially since the past decade and a gradual shift towards renewables is increasing to meet the demand. In this paper we have analyzed the status of the global PV market and the time when critical point of generated PV waste will reach. We have also discussed about the need for PV waste management and recycling, and also the ways how policies and regulations can help for the same.

312	Performance Enhancement of an Axial Flow Hydrokinetic Turbine by optimizing the Length of Elliptical Exit Duct
------------	---

Vimal Patel^{1*} and Vasava Rahul V. +

¹ Assistant Professor SVNIT, Surat-395007

² Research Scholar SVNIT, Surat-395007

*vimal.svnit@gmail.com, +vasavarahul174@gmail.com

Axial flow hydrokinetic turbine uses the kinetic energy of the water to produce mechanical energy. With the past study, it was concluded that the exit duct plays a vital role in the performance of the Axial flow hydrokinetic turbine. In the present investigation, an innovative elliptical exit shape of the duct is considered for the performance evaluation. The length of the elliptical exit duct is investigated with numerical simulations and the optimum length required for the performance enhancement is derived. The analysis has been carried out for six different lengths of duct. The property of

the fluid is taken at STP and free stream velocity is taken as 0.36 m/s. The numerical simulation indicates the maximum coefficient of power 0.209 at 182 mm duct length. From the present investigation, it is concluded that minimum 5D length of the exit duct is necessary for best performance of the Axial flow hydrokinetic turbine for the considered variables.

314

CVD growth of Titanium dioxide nanorod on shape memory (NiTi) alloy for energy storage application

Sakshum Khanna¹, Roma Patel¹, Priyanka Marathe¹, Rakesh Chaudari², Jay Vora², Abhijit Ray¹, Indrajit Mukhopadhyay^{1*}

¹Department of Solar Energy, Pandit Deendayal Petroleum University, Gujarat, India

²Department of Mechanical Engineering, Pandit Deendayal Petroleum University, Gujarat

*Indrajit.m@sse.pdpu.ac.in

Nanostructured TiO₂ has an exceptional physical and optical properties which has attracted the researcher's attention in the area of energy conversion and storage application. In the current study, we report the development of camphor based rutile Titanium Dioxide nanorods (TiO₂ NR's) on superelastic shape memory NiTi alloy using chemical vapor deposition technique for energy storage application. The systematic study was performed by varying the camphor concentration (3mg-7mg) along with the change in the temperature (900°C-1100°C). The nucleation and growth were observed for the lower concentration, while the nanorods formation were developed at higher camphor concentration at 950°C. The formations of nanorods were characterized by scanning electron microscopy, Raman spectroscopy and X-ray diffraction resulting in determining the rutile phase of the nanorods with a length and diameter of 10-12µm and 60-100nm, respectively. It was observed that the growth of the titanium nanorods was dominated by the presence of nickel as catalysis and the enhancement of the nanorod was due to the presence of oxygen in the camphor. Further, electrochemical analysis showed the specific capacitance ~1 F/g with 7% degradation over 100 cycles revealing good stability of the active material. The resulting TiO₂ nanorods exhibited high-quality crystallinity and large surface areas with high index surface, which can be used as one of the promising material for various energy storage applications.

315

Localized Energy Self Sufficiency (Energy Swaraj) for Energy Sustainability and Mitigating Climate Change

Chetan Singh Solanki, Sayli Shiradkar*, Rohit Sharma, Jayendran Venkateswaran, Nikita Lihinar, Harshad Supal, Swati Kalwar

Indian Institute of Technology Bombay, Mumbai 400076, India

*sayli.bhide@gmail.com

Mitigating climate change is one of the major global concerns of the 21st century. Increasing energy consumption and dependence on conventional fuels is the primary challenge to contain global warming. The world needs to switch towards renewable energy sources and utilize energy efficiently for sustainability and to reduce greenhouse gas emissions. In this context, decentralized renewable energy access based on the Gandhian principle “-not mass production but production by the masses " would be useful for energy sustainability and to address United Nation Sustainable Development Goals (SDGs). The authors present a

conceptual model wherein local communities get involved in generating and fulfilling their own energy needs which is technically feasible and economically viable. Based on this approach, Solar Urja through Localization for Sustainability (SoULS) initiative is implemented in rural areas of 9 states in India to provide clean, affordable, reliable and complete energy access. Local people are trained to own, manage, and operate solar enterprises at every level including assembly, distribution, after-sales service, and manufacturing to create solar energy ecosystem by locals for locals. The SoULS project at IIT Bombay has demonstrated that by involving local community in fulfilling their energy needs, growth can be observed across other dimensions of development including social, economic, environment, institution and technology. Preliminary field findings from impact analysis of the implementation are discussed. This paper presents the conceptual model of localized energy self-sufficiency (LESS) or Energy Swaraj approach and brings the idea of how the deployment of renewable energy technologies can become sustainable over time.

316

Pseudocapacitive energy storage in Copper Oxide and Hydroxide Nanostructures casted over Nickel-foam

Priyanka Marathey, Sakshum Khanna, Roma Patel, Indrajit Mukhopadhyay, Abhijit Ray*

Solar Research and Development center, Department of Solar Energy, Pandit Deendayal Petroleum University, Raisan, Gandhinagar, Gujarat, India 382007

*abhijit.ray1974@gmail.com

In the present study we investigate the pseudocapacitive behavior of the copper hydroxide-oxide nanostructures casted over Ni-foam. Highly textured nanorods of copper oxide and hydroxide were developed over the copper foil (Cu-F) using wet-chemical etching technique. Structural and morphological analysis of the prepared material was carried out using scanning electron microscopy, tunneling electron microscopy and X-ray diffraction spectroscopy, which confirms the formation of nanorods with large surface area and presence of dominant (002) and (130) planes of copper hydroxide ($\text{Cu}(\text{OH})_2$), (-111) and (111) planes of copper oxide (CuO), which are highly favorable for charge storage applications. Further, the active material (nanorods) was loaded over Ni-foam. In an order to determine the pseudocapacitive behavior, electrochemical studies were conducted. The specific capacitance of the copper hydroxide-oxide nanostructure casted over Ni-foam was found to be ~ 2 F/g. Electrochemical frequency measurements were conducted to investigate the electrode charge transfer kinetics for the electrodes. The electrochemical impedance spectroscopy reveals that electrode having copper hydroxide-oxide mixed phase exhibit faster charge transfer kinetics and lower equivalent series resistance as compared to the electrodes having crumbled pure copper oxide nanorods.

317

Validation of computer code based on Nodal Integral Method against KAPS-2 Phase-B data**Manish Raj^{1*}, Sherly Ray¹, A.S. Pradhan¹ and Suneet Singh²**¹ Nuclear Power Corporation of India Ltd., Mumbai-94, India² Indian Institute of Technology Bombay, Mumbai-76, India

*rmanish@npcil.co.in

One of the major activities involved in the operation Indian PHWRs includes commissioning of nuclear reactor before commercial operation of reactor. The commissioning activities can be divided into three principal phases viz. Phase-A, Phase-B and Phase-C. The commissioning program assures that the plant is made operational in a systematic, informative and safe manner after its construction. It also verifies that the performance criteria, design intent and quality assurance requirements are satisfied. Phase-B Tests are performed up to 0.1%FP and its objectives are to confirm that the reactor is suitable for start-up and power operation and to check that core characteristics, control systems, reactor physics parameters are satisfactory. Important activities in Phase-B include initial fuel loading, addition of heavy water into PHT and moderator, first approach to criticality and low power physics tests. Some of the Phase-B results of Kakrapar Atomic Power Station-2 (KAPS-2) commissioned in 2018, are compared with the theoretical estimations carried out by computer code based on Nodal Integral Method (NIM). The variation of neutron count rates during approach to criticality, critical boron and the worth of reactivity devices etc. are compared with the observation at KAPS-2.

318

Bi-Polar DC Micro Grid based Wind Energy System**Satish Reddy Dodda¹, Suman Kumar², Bonala Anil kumar³, Srinivasa Rao Sandepudi^{4*}**^{1,2,3,4} Department of Electrical Engineering

N.I.T Warangal - 506 004, Telangana State, India,

*ssr@nitw.ac.in

This paper describes a bi-polar DC micro grid with a predictive controlled three-level boost converter interfaced wind energy conversion system (WECS). The micro grid consists of a permanent magnet synchronous generator (PMSG) based wind energy conversion system, battery energy storage system (BESS) on each pole with DC-loads. The BESS is interfaced to each pole of the bi-polar DC micro grid with a bi-directional buck-boost converter which regulates the individual pole voltages to its reference. The power imbalance in each pole due to unbalanced loading/power generation will lead to the deviation in the pole voltages. In order to balance these bi-polar DC- link voltages, a three-level boost converter (TLBC) is used to interface the PMSG and a predictive control is developed to achieve the objectives of maximum power extraction and balancing of bi-polar DC-link voltages. Simulation studies are carried using Matlab/Simulink to examine the performance of the controller for variation in loads and power generation and results are found to be satisfactory.

320

Processing thermogravimetric analysis data for pyrolysis kinetic study of microalgae biomass**Pravin G. Suryawanshi¹ and Vaibhav V. Goud^{1*}**¹ Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati-781039, India

*vvgoud@iitg.ac.in

Microalgae is fast-growing, concentrate source of lipid and economically viable third-generation feedstock for biofuels. For the modeling of thermochemical conversion processes a detailed kinetic analysis is inevitable. A comprehensive analysis of thermal degradation characteristics and pyrolysis kinetics of *Scenedesmus* sp. microalgae is carried out using thermogravimetric analysis (TGA). A non-isothermal thermogravimetric data was obtained by heating the microalgae sample from 25°C to 800°C, with four different heating rates 10, 20, 30 and 50°C min⁻¹, under atmospheric conditions using nitrogen gas. The differential thermal gravimetric (DTG) used to determine thermal behavior and reaction steps, where 14.15 wt% min⁻¹ degradation rate was observed at 50°C min⁻¹ heating rate. The production of high volatile organic with less ash formation demonstrate the utilization potential of microalgae biomass for biofuel production. Model-fitting and model-free isoconversional integral kinetic methods employed to accurately determine the kinetic triplets of the pyrolysis process. From the knowledge of activation energy and pre-exponential parameter, the thermal degradation mechanism of the biomass determined using master plot method. The kinetic parameters calculated using isoconversional integral kinetic methods show good agreement. The kinetic analysis resulting from this study can be utilized for modeling thermochemical conversion of microalgae biomass to design the pyrolysis process for biorefinery.

324

Photovoltaic Thermal Collectors with Phase Change Material for Southeast of England**Preeti Singh¹, Rajvikram Madurai Elavarasan², Nallapaneni Manoj Kumar³, Sourav Khanna^{4*}, Victor Becerra⁴, Sanjeev Newar¹, Vashi Sharma¹, Jovana Radulovic⁴, Rinat Khusainov⁴ and David Hutchinson⁴**¹ IIT Kanpur, Uttar Pradesh 208016, India² Sri Venkateswara College of Engineering, Tamil Nadu 602117, India³ City University of Hong Kong, Kowloon 85PF+87, Hong Kong⁴ University of Portsmouth, Portsmouth PO1 3DJ, UK

*sourav.khanna1@gmail.com

Temperature elevation of solar photovoltaic (PV) in the exposure of sun should be bound to avoid the fall in efficiency. Phase changing material (PCM) is a proven technology to capture the waste heat of photovoltaic. It provides cooling to PV, increase in efficiency and storage of waste heat. In this paper, the thermal conductivity of PCM heat sink is enhanced by using fins. The dual effect of PCM and fins is explored to increase the efficiency of the photovoltaic collectors. Different types of phase change material arrangements are investigated. Twenty collectors of 200Wp original PV are compared with the photovoltaic thermal PCM collectors. It is conveyed that, at Southeast England, the collected electricity is

boosted by 1.20, 1.33, 1.40, 1.43 and 1.44 kWh/day through different types of phase change material arrangements.

327	Modeling and Simulation of Hollow Membrane Biocatalyst Membrane Reactor
------------	--

Nooram Anjum^{1*}, Mohammad Danish¹ and Sarah Anjum²

¹ Department of Chemical Engineering, AMU, India

² University Polytechnic, AMU, India

*nooramanjum@zhcet.ac.in

Hollow fiber bio-catalytic membrane reactors combine selective mass transport with chemical reactions using tubular geometry. The selective removal of products from the reaction site increases the thermodynamically unfavorable reactions. A mathematical model has been developed comprising of a set of two non-linear ODE's where one of the ODEs is a second order BVP in radial direction (depicting diffusion-reaction in radial direction in spongy region) while the other ODE is a first order IVP in axial direction (depicting a classical PFR performance equation at steady state). A MATHEMATICA based program has been developed to numerically simulate Hollow Fiber Biocatalyst Membrane Reactor and compare it with an available approximate expression for effectiveness factor. Using this program, effectiveness factor at various locations in the reactor has been successfully evaluated and validated with the available literature results for the developed model. Effectiveness factor has also been evaluated and compared between the two approaches for different reaction kinetics. This study is quite useful for the future use of biocatalyst reactors for arbitrary reaction kinetics at an industrial level.

329	Efficient Alkaline Peroxide Pretreatment of Sterculia foetida Fruit Shells for Production of Reducing Sugar: Effect of Process Parameters on Lignin Removal
------------	--

S Sardar^{1*}, A Das¹⁺, S Saha^{1#}, C Mondal^{1}**

¹ Chemical Engineering Department., Jadavpur University, Kolkata 700032, India.

*sujata.sardar@jadavpuruniversity.in, ⁺aridtas94@gmail.com, [#]sudeshna.saha@jadavpuruniversity.in,

**chanchal.mondal@jadavpuruniversity.in

The efficient delignification of low-cost lignocellulosic biomass is of utmost importance for its viable conversion to biofuel. In the current study, agricultural waste biomass of *Sterculia foetida* fruit shell was pretreated by heating at 60°C and 121°C in presence of alkaline and alkaline peroxide conditions. The purpose was to study the effects of the concentration of NaOH & H₂O₂ and temperature on the lignin removal efficiency and the reducing sugar content. Also the structural and functional changes caused to the biomass were studied using FTIR and XRD analysis. The results showed an increase in crystallinity of the pretreated samples which indicated the removal of lignin as well as easy accessibility of cellulose. The optimum lignin removal of 81.66% was achieved by heating at 60°C for 3 hours using 3% H₂O₂ and 5% NaOH aqueous solution. A maximum reducing sugar yield of 220 mg/g was obtained. It was found that at higher chemical concentrations the yield decreased due to the

in-situ degradation of the released sugars in presence of NaOH and H₂O₂. The developed pretreatment procedure showed appreciable delignification of the biomass which could be easily scaled up for continuous operations at low costs.

330

Performance Enhancement of Savonius Hydrokinetic Turbine with a Unique Vane Shape: An Experimental Investigation

Vimal Patel^{1[2]}, Kushal Shah¹, Vikram Rathod¹

¹ Sardar Vallabhbhai National Institute of Technology, Surat, INDIA

^[2] vimal.iitbombay@gmail.com

Hydrokinetic turbine produces the power output from the kinetic energy available in the flowing water flow. For power production, there is no need of massive construction of dam and power can be derived without changing the natural path of the water stream. In spite of many advantages of the hydrokinetic turbines, it suffers with the biggest drawback of very low power coefficient. Hence, in the present investigation, an attempt is made to enhance the performance of the Savonius hydrokinetic turbine by evaluating novel designs of the vane shapes. Two different types of the vanes are investigated, considering the efficiently flow pattern passing over from the turbine vane. The performances of the designed vanes are compared with the third conventional semi cylindrical vane. The performances of all turbine vanes are investigated experimentally. The experimental results indicate that the extended semi cylindrical vane, design – 1, provides the best performance among all investigated turbine vane designs.

331

Techno-economic Analysis for Production of Biodiesel and Green diesel from Microalgal oil

Swarnalatha Mailaram¹, Nitesh Dobhal¹ and Sunil K. Maity^{1*}

¹ Department of Chemical Engineering, Indian Institute of Technology Hyderabad, Kandi, Sangareddy-502 285, Telangana, India

*sunil_maity@iith.ac.in

Microalgae has massive potential for the production of biofuels. Thermochemical conversion of microalgal oil is the potential route to produce diesel range biofuels. This work provides the process design using Aspen Plus and economic analysis for transesterification and hydrodeoxygenation of microalgal oil to produce biodiesel and green diesel, respectively. In the present study, the microalgal oil derived from *Nannochloropsis salina* is considered as feedstock. Capital, operating expenses and the manufacturing cost of the biodiesel and green diesel have been estimated for various plant capacities ranging from 0.05 to 0.15 million metric ton microalgal oil per annum. The effect of plant capacity and different cost-contributing factors on the manufacturing cost of biodiesel and green diesel has also been studied. The manufacturing cost of diesel oil-equivalent biodiesel and green diesel was USD 4.425 and USD 4.294 per kg, respectively.

334

Numerical Investigation on the Effect of EGR in a Premixed Natural Gas SI Engine**Sridhar Sahoo^{1*}, Srinibas Tripathy¹, and Dhananjay Kumar Srivastava²**¹ School of Energy Science and Engineering² Department of Mechanical Engineering, IIT Kharagpur

*sridharsahoo366@iitkgp.ac.in

Compressed natural gas (CNG) is considered as a promising alternative fuel for spark ignition engines. Higher antiknock quality of CNG is best utilized when the engine will operate at a high compression ratio. Engine exhaust emission at higher compression ratio might be a changeless, particularly NO_x emission. However, power output and emission in the CNG engine are still a challenge. Thus, the engine can be operated with EGR dilution at the stoichiometric operating condition. In this paper, numerical simulation on the effect of EGR rate in a SI CNG engine was conducted. A very good agreement between experimental and simulated pressure trace was obtained for validation of the model. The performance output, combustion behavior, and emission analysis were investigated by varying EGR rate (0% to 20%). Significant reduction in power output and IMEP were observed with the introduction of EGR. Combustion pressure and heat release rate were found decreasing due to lower available chemical energy, longer combustion duration and slow chemical reaction rate of the EGR mixture. However, a substantial reduction in CO and NO_x emission were noticed with the introduction of EGR. This study shows that the EGR rate between 10% to 15% gives satisfactory result from performance and emission point.

335

Transitions in the Indian Electricity Sector: Impacts of High Renewable Share**Aishwarya Iyer^{1,2,*}, Rangan Banerjee²**¹School of Forestry and Environmental Sciences, Yale University, New Haven, Connecticut 06511, USA²Department of Energy Science and Engineering, IIT Bombay, Powai, Maharashtra, 400076, India

*aishwarya.iyer@yale.edu

India's aggressive plan to increase the share of renewables in electricity generation capacity from 43GW in 2015 to 175GW in 2022 is expected to have implications on not only the power sector, but also the consumers, the economy and the environment. This project describes a simple aggregate model created to analyse macro effects of any future electricity generation mix scenario. It uses MATLAB to create this model, which takes input variables like demand shape, electricity yield from solar and wind, both for 12 representative days of a year (one from each month). It also uses average hourly demand and growth rate, renewable installed capacity projections, ramp rate limits for thermal power plants to define scenarios. This paper showcases results for 2040 with different load curves, high and low renewable penetration levels. The results include storage requirements, cost changes, PLF of coal power plants, CO₂ emissions of the different scenarios. The study also looks at Delhi and Mumbai demand curves. The model can be customized for any city, state or country, and be projected to any final year of analysis. The results are intended to inform policy decisions on an aggregate scale.

336

Comparison of Physics Characteristics of Pressurized Water Reactor Type Advanced Light Water Reactors**L Thilagam^{1*} and D K Mohapatra¹**¹ Safety Research Institute, Atomic Energy Regulatory Board, Kalpakkam 603 102, India

*thilagam.aerb@gov.in

Advanced light water reactor (LWR) systems with improved passive safety features, that claim to meet Generation III+ safety criteria, are of growing interest worldwide in meeting future energy demand. As an effort to understand the basic differences in lattice and core physics aspects of such advanced LWRs, preliminary steady state reactor physics analyses are carried out for some of the pressurized water reactor (PWR) type of advanced LWRs like Westinghouse AP-1000 and European/Evolutionary PWR EPR-1650. The reactor physics parameters such as neutron multiplication factors, core average neutron flux spectra, worth of control systems, various reactivity coefficients and effective delayed neutron fraction are calculated and compared with the Russian PWR design VVER-1000 reactor for a clean initial core configuration at hot operating conditions. A lattice burnup code, DRAGON and a Monte Carlo (MC) code are used for the purpose. The study not only highlights the differences in nuclear design and estimated core physics parameters of VVER- 1000, AP-1000 and EPR-1650 reactors but also demonstrates the capability of advanced reactor physics computer codes available for safety evaluations of such reactor systems.

337

Development Of A Python Module “SARRA” For Refuelling Analysis of MSR Using DRAGON Code**A. K. Srivastava, Anurag Gupta, Umasankari Kannan**

Reactor Physics Design Division

Bhabha Atomic Research Centre, Mumbai 400085

ashishks@barc.gov.in

The renewed interest in molten salt reactor (MSR) is primarily due to several advantages and unique characteristics pertaining to online refuelling and reprocessing of molten salt fuel. Thus, there is need of development of computational tools for analysis of online refuelling and reprocessing of circulating fuel systems like MSRs. A python module, SAlt Refuelling and Reprocessing Analysis (SARRA), as a computational tool is being developed, which utilises lattice code DRAGON for MSRs specific analysis like online refuelling and reprocessing. In the present paper, the online refuelling and removal capabilities of molten salt fuel has been analysed at lattice level for MSRE lattice. The results of analysis are presented in paper.

338

The effect of Concentrator ratio and Thermocouples on Photovoltaic-Thermoelectric Hybrid Power Generation System**Abhishek Tiwari¹ and Shruti Aggarwal¹**¹ University School of Basic and Applied Sciences, Guru Gobind Singh Indraprastha University, Sector-16C, Dwarka, Delhi-110078, India
abhi.twr21@gmail.com

In this paper, a theoretical model has been developed for a concentrated PV module integrated with a thermoelectric module (CPV-TEG) and simulated in MATLAB. The effect of simultaneous variation of concentration ratio of concentrator (C) and number of p-n thermocouples of TEG module (N) on the power output and electrical efficiency of PV module, thermoelectric generator (TEG) module and the hybrid system on whole has been studied. The variation in the temperature of PV module (T_{PV}) and the temperature difference across the thermoelectric module (ΔT_{TE}) due to simultaneous variation in C and N has also been studied. The results illustrate that the power output of PV module (P_{PV}), power output of TEG (P_{TE}) and power output of hybrid system (P_{HS}) achieved maximum value at $C=2$ $N=127$. The maximum temperature and minimum efficiency of PV module was observed at $C=2$ $N=1$. For TEG, maximum temperature difference and minimum efficiency was observed at $C=2$ $N=1$ and $C=1$, $N=127$ respectively.

339

Evaluation of annual electrical energy through semitransparent (glass to glass) and opaque photovoltaic module in clear sky condition at composite climate: A comparative study**Rohit Tripathi^{1,3[*]}, G. N. Tiwari² and T. S. Bhatti²**¹School of Electrical, Electronics & Communication Engineering, Galgotias University, G. Noida, India²Bag Energy Research Society (BERS), SODHA BERS COMPLEX, Plot No. 51, Mahamana Nager, Varanasi, UP, India³Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016

*rohittripathi30.iitd@gmail.com

In present paper, two types of PV module technologies have been considered for evaluation: one is semitransparent (glass-to-glass) and second is opaque (glass-to-temlar). The comparative detailed analysis has been made an attempt for definite parameters like the temperature dependent electrical efficiency of solar cell, PV module and electrical energy. The area of each PV module is 0.605 m² and output wattage is 75 Wp. The solar cell material is poly crystalline silicon for each module. The annual performance of PV module for both types is also studied. Arithmetic computations have been carried out for clear sky condition of composite climate: Delhi, India. It has been observed that opaque PV module is dominated by semitransparent PV module in generating electrical outputs. The electrical efficiency of PV for opaque is obtained 18.5 % higher than semitransparent PV module. The annual electrical energy gain for opaque is evaluated 3.50 kWh whereas 2.95 kWh for semitransparent which is 1.18 times higher than semitransparent PV module.

340	Current Practices and Emerging Trends in Safety Analysis of NPPs
------------	---

Obaidurrahman K.

Nuclear Safety Research and Analysis Group
Atomic Energy Regulatory Board, Anushaktinagar, Mumbai, India
obaid@aerb.gov.in

Safety analysis is an important element of overall safety assessment and licensing process, which is used to comprehensively demonstrate that nuclear facility meets the desired safety goals. Analysis of a given initiating event requires mathematical modeling and numerical simulation of one or many physical phenomenon occurring in the plant which necessitates complex computer codes. Overall methodology and computation tools used in safety analysis have evolved continuously. Plant states considered in safety analysis and their classification has also evolved gradually. This paper presents an overview of evolution of safety analysis methods and associated computational tools. Presently practiced safety analysis approaches and emerging trends have been discussed.

342	Internalizing the external cost of Gaseous and Particulate matter emissions from the coal-based thermal power plants in India
------------	--

P. Srinivasan^{1*} and Anand Shekhar²

¹ Department of Mechanical Engineering, Birla Institute of Technology and Science (BITS), Pilani, Rajasthan, 333031. India.

² Centre for Analytical Finance, Indian School of Business (ISB), Hyderabad, Telangana, 500032. India.

*psrinivasan@pilani.bits-pilani.ac.in

Economist's version of cost of power generation does not take into consideration the effect of environmental impact during the power generation. Cost estimated by taking the environmental impact during the power generation from the environmentalist perspective is popularly known as internalizing the external cost. In the present work, an attempt is made to calculate the external cost per unit of electricity generation from the coal-based power plants in India. Sulfur dioxide (SO₂), oxides of nitrogen (NO_x), particulate matter (PM) and carbon dioxide (CO₂) are considered in the present analysis. Purchase power parity (PPP) and population density correction factor have been used to better represent the external cost in Indian economic and demographic context. Total external cost for coal-based power plants in India comes out to be INR 4.05 trillion/year and cost per unit of electricity generated is estimated to be INR 3.67/kWh in the year 2015. Cost of power generation from coal-based power plants in India with and without considering the internal cost is estimated till the year 2050 based on the demand forecast. Comparison is also made between the cost of solar power generation and coal-based thermal power generation to predict the techno-economic viability of exploiting more solar-based power generation. It is predicted that the cost of solar power generation is cheaper than the power generation from coal-based power plants if the external cost of power generation is included in the generation cost.

344

Electrochemical Reduction Of CO₂ On Ionic Liquid Stabilized Reverse Pulse Electrodeposited Copper Oxides.**Nusrat Rashid¹, Pravin P. Ingole^{1*}**¹ Indian Institute of Technology Delhi, New Delhi, India - 110016

* Ingole.iitdelhi@gmail.com

We, with this work report the effect of ionic liquid (IL) as an additive in electrolyte bath for electrodeposition of copper oxides, their self-assembly and activity towards CO₂ reduction. For further analysis we studied the effect of intermittent pulsed current, null pulses as well as negative polarity pulses on the self assembly of copper on carbon fiber paper (CFP), its crystallinity and its electrocatalytic behavior towards reduction of CO₂ into fuels of importance. The physical characterization of deposited films was done with techniques like XRD, SEM, TEM and FTIR. The gaseous products obtained were detected by GC and liquid products were analyzed by NMR. We found a strong dependence of CO₂ reduction activity on the mode of deposition and presence of IL in the electrolytic bath.

345

Performance of Flux Mapping System during spatial xenon induced oscillations in PHWRs**Abhishek Chakraborty *, M.P.S.Fernando, A.S.Pradhan**

Fuel Physics Shielding and Safeguards Group, Engineering Directorate, NPCIL, Mumbai

* abhishekc@npcil.co.in

Pressurized Heavy Water Reactors (PHWRs) are Natural Uranium fueled pressure tube type reactors which use heavy water as coolant and moderator. Large PHWRs are neutronically loosely coupled and are prone to spatial xenon instabilities. In core instrumentation for monitoring and Liquid Zone Compartments (LZCs) are provided for suppressing these local oscillations in addition to global power control. Since, the zonal instrumentation measure the local flux, they have to be corrected. Flux Mapping System (FMS) is present in large PHWRs to correct the zonal detector readings. This system uses flux synthesis method and reconstructs the flux shape in the reactor with the help of several vanadium Self Powered Neutron Detectors (SPNDs). FMS will also provide power trimming functions based on different parameters and these will be very important during the operation at full power for PHWRs which have boiling at the exit. In this paper, the comparison of the estimations of the Flux Mapping System is done with those obtained from the solution of the space-time dependent neutron diffusion equation using Improved Quasistatic Approximation (IQS) approximation is carried out for situations with limited spatial power control which demonstrates the accuracy of the FMS estimations when the regional powers are allowed to oscillate. Based on these simulations, experiments involving spatial xenon oscillations will be planned in the upcoming 700 MWe PHWR to verify the accuracy of FMS during such oscillations.

347

Forecasting of Electricity Demand and Renewable Energy Generation for Grid Stability**Joel Titus, Urvi Shah, T. Siva Rama Sarma, Bhushan Jagyasi, Pallavi Gawade, Mamta Bhagwat, and Arnab De***

Accenture, Advanced Technology Centers in India, India

*arnab.k.deg@accenture.com

The electricity generation units, network operators and consumers operate in-sync by making commitments based on their projections of the consumption and generation capacities. The balance between generation and demand is very important for smooth operation of the system, reduction in the harmonics and losses, and moreover for the grid stability. This requires accurate forecast of electricity demand along with its self sufficiency in terms of renewable energy generation. The short term forecasting of electricity demand and its generation from the renewable sources like solar and wind has been considered in this paper. An hourly forecasting of electricity demand, solar generation and wind generation has been carried out with 24 and 48 hours advance forecasting. To maintain the stability of the grid it is important to generate the electricity with due consideration to solar and wind generation. We hence present the machine learning based models to directly forecast the net generation requirement of electricity with solar and wind generation data. We present the exhaustive results to analyze these forecasts with and without the availability of future weather information. For various machine learning algorithms, forecasting accuracy has been compared for different seasons, days of the week and hours of the day to evaluate the robustness of the algorithms.

348

Platooning of Flat Solar Panel Mounted Mini Bus Model – A Numerical Investigation**Mohammad Rafiq*, B. Agrewale¹ and R. S. Maurya^{2#}**¹ Research Scholar, Sardar Patel College of Engineering, Mumbai, India² Associate Professor, Sardar Patel College of Engineering, Mumbai, India

*engg_rafiq@yahoo.co.in, # r_maurya@spce.ac.in

In the view of limited source of conventional fuel and environmental concern, the researchers are working on alternative energy source for automotive applications. One of the way is to utilizing solar energy by using rooftop solar panel on ground vehicles. But any geometric change in exterior vehicle body, disturb flow around it which affect drag and lift coefficient significantly. The aerodynamic drag plays a significant role to define overall performance of ground vehicle in terms of fuel economy. Also, the effect of yaw angle is more significant in some cases. The various technologies are being developed and used in the field of automotive aerodynamics, to reduce drag. The vehicle platooning is one such emerging idea where the drag is decreased by driving the vehicles in a platoon. The objective of present work is numerical investigation of aerodynamic behaviour of flat solar panel mounted mini bus model under platooning effect. First numerical investigation is carried out to assess the impact of flat solar panel on the coefficient of drag. To validate numerical result, the wind tunnel test is performed on scaled down prototype model and results shows the close correlation between experimental and numerical analysis. Further numerical investigation has been carried out with combination of two and three vehicles in a platoon, considering variation of separation distances from 3 to 12m for range of speed from 80 - 120kmph. Also, numerical investigation

is carried out by considering variation of yaw angles from 6 to 18 degree for selected separation distance at 80 kmph. The result shows significant changes in drag and lift coefficient under platooning effect.

349	Microbial electrosynthesis for biofuel generation
------------	--

Sadaf Shakeel and Dr Mohammad Zain Khan

Environmental Research Laboratory, Department of chemistry, Aligarh Muslim University, Aligarh
India

Microbial electrosynthesis (MES) is a new aspect of bioelectrochemical system that generates valuable chemical products and biofuel via microbial reduction of carbon dioxide at cathode with the help of

external voltage supply. Formation of ethanol from MES is still not explored much yet. Previous literature suggests that for bacteria mediated acetogenesis, high carbon dioxide concentration is needed, for conversion of acetate to ethanol, high partial pressure of hydrogen (pH 2) and low partial pressure of carbon dioxide (pCo 2) is required. In situ hydrogen generation plays a very important role in maintaining high pH 2. A cathodic material of better catalytic activity that could enhance in situ hydrogen formation and may results into better yield of ethanol . Our study is focused on enhancing catalytic activity of cathodic material to achieve improved ethanol yield via MES.

351	Co-sensitization of perovskite solar cells by organometallic compounds: Mechanism and photovoltaic characterization
------------	--

Nisha Balachandran^{[1][2]}, Temina Mary Robert^[1], Dona Mathew^[1], Jobin Cyriac^[2]

^[1] Propellants, Polymers, Chemicals and Materials Entity, Vikram Sarabhai Space Centre, Thiruvananthapuram – 695 022, Kerala, India

^[2] Department of Chemistry, Indian Institute of Space Science and Technology, Thiruvananthapuram – 695 547, Kerala, India
nishapzm@gmail.com

Organic–inorganic halide perovskites constitute a new emerging class of materials for solar cell applications. In this paper, we report synthesis of methyl ammonium lead bromide (CH₃NH₃PbBr₃) hybrid perovskites doped with the bipyridyl based Ruthenium dye-N719. Doping with the dye on CH₃NH₃PbBr₃ exhibits a broad absorption peak in visible region with a shift in band gap from 1.66 eV to 1.51 eV. The influence of doping on optical properties and current-voltage characteristics were studied using microscopic, spectroscopic and photovoltaic characterization techniques. Photovoltaic power conversion efficiencies (PCEs) in the range of 4.8 -6.8 % were observed for the dye doped perovskites solar cells. Short-circuit current densities were in the range of (J_{sc}) of 1.5 to 2.1 mA/cm² with open circuit potential (V_{oc}) ~0.96-V and fill factors (FF) in the range 60 % under illumination of 100 mW /cm² . The corresponding efficiencies and current density values for the undoped perovskites were ~1% and ~ 0.6 mA /cm² respectively, clearly indicating the establishment of co-sensitization.

Potential of co-sensitizing agent on the photovoltaic performance of perovskite solar cells is being reported for the first time.

352	Nuclear Power Plants and Human Resources Development in South Asia
------------	---

Firoz Alam^{1*}, Rashid Sarkar², Akshoy Ranjan Paul³, and Abdulaziz Aldiab^{1,4}

¹ RMIT University, Melbourne, VIC 3083, Australia

² Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh

³ Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj 211004, India

⁴ Imam Abdurrahman Bin Faisal University, Dammam, Saudi Arabia

*firoz.alam@rmit.edu.au

The clean energy demand for industrial and socio-economic development necessitates developing countries to seek nuclear energy/technology for power generation to supplement and reduce their absolute dependency on fossil fuel. However, the lack of skilled manpower is one of the main constraints to achieve this goal. Moreover, the lack of nuclear experience, knowledge, educational infrastructures and resources is another constraint for developing skilled human resources for the safe use of nuclear technology in emerging countries. This paper discusses the recent trend in worldwide nuclear energy plant growth in the developing countries and the need for qualified manpower development programs for viable nuclear energy plant design, construction, operation, maintenance, se-cured repair and cost effective use. The paper also enlightens the nuclear engineering education in South Asia.

354	Chilled Water Circuit Energy Optimization in a Centralized HVAC Plant in Commercial Buildings
------------	--

Ananthapadmanabhan G S^{1*} and Divya Kritika²

¹ Smart Joules Pvt Ltd, Civil Lines, New Delhi 110054

² Smart Joules Pvt Ltd, Civil Lines, New Delhi 110054

*ananthapadmanabhan@smartjoules.in

The objective behind this optimization strategy is to identify the pockets of improvement in the chilled water distribution system in a Centralized Air Conditioning plant in a commercial building. The chilled water circuit can have primary and secondary configuration depending upon the building cooling requirement and heat load patterns. This paper discusses a primary variable chilled water distribution system and the way in which the system is optimized in terms of energy consumption without compromising on the comfort conditions of the occupants of the area. The popular misconception in this regard is that by designing a new system or retrofitting an older pumping system with state-of-the-art equipment's will yield the investor persistent savings over time. A new pump if not operated optimally would end up consuming more power and contribute to poor kW/TR of the chiller plant. In all new age chilled water distribution systems motorized two-way/ three-way valves are installed for optimizing the chilled water distribution system. But due to the absence of an adequate Building Management System which is capable of monitoring the valve position and provide actionable intelligence to the user for optimizing the chilled water circuit, these valves end up in a bypassed state resulting in wast-age of energy in the chilled water distribution system. Smart

Joules Pvt. Ltd. offers complete solution to this problem through its BMS named DeJoule which is discussed in detail in this paper.

355	Effect of Selenium substitution in thermoelectric Properties of multilayers of Bi₂Te₃ and Sb₂Te₃ compounds
------------	---

Y. C. Sharma* and M. Kumari

Department of Physics, Vivekananda Global University, Jaipur, 303012, India

*yc.sharma.vit@gmail.com

In present era there is a need to develop modes and methods for harvesting of waste heat. Telluride compounds are very good thermoelectric materials. They have shown excellent thermoelectric properties around 50°C – 200°C. Studies have shown that their multilayer designs have better thermoelectric properties. In this work we report substitution of selenium with tellurium in the multilayer thin films of Bi₂Te₃ and Sb₂Te₃ compounds. Single layer thickness of about 50 nm which were fabricated using electron beam assisted thermal evaporation on glass and Si substrate. The electrical properties i.e. Hall measurements, carrier concentration, carrier mobility, conductivity have been studied at room temperature. Thermoelectric behavior has been analyzed on the basis of Seebeck coefficient for which our samples show result in coherence to earlier reported values. X-Ray diffraction (XRD) and atomic force microscopy (AFM) and Scanning Electron microscopy (SEM) techniques have been employed to inquire the crystallographic structure and surface morphology of specimen. Cross sectional TEM analysis has also been done to verify and analyse the formation of the multilayer system.

356	Highly Stable Pt/CVD-Graphene Coated Superstrate Cu₂O Photocathode for Water Reduction
------------	--

Chandan Das*, Akhilender Jeet Singh, and K. R. Balasubramaniam

Department of Energy Science and Engineering, Indian Institute of Technology Bombay, Mumbai, 400076, INDIA

*chandan.dese@gmail.com

Here, we demonstrate a highly stable protected superstrate architecture Cu₂O photocathode for water reduction. The Cu₂O layer was electrodeposited on F-SnO₂ (FTO) substrate via a modified method to obtain larger grains, 3.0 – 4.0 μm size owing to minimize the short-circuit current at the grain boundaries. Chemical vapor deposited (CVD) Graphene being a robust material, also possesses the requisite properties (work function 4.6 eV and high conductivity) for cathode protection was coated on top of the device. Pt cocatalyst (30 nm) was deposited via e-beam evaporator on top of CVD Graphene to enhance the hydrogen evolution reaction (HER) kinetics at the electrode-electrolyte interface, also helped in blocking the microcracks in the Graphene layer. The transparent FTO substrate enables back-illumination during the experiment, thereby allowing a non-transparent protective coating. This protected device shows stable photocurrent generation of ~ 2.5 mA cm⁻² under one sun illumination in 1 M Na₂SO₄ electrolyte for one hour of the experiment.

358

Thermodynamic Studies on Steel Slag Waste Heat Utilization for Generation of Synthesis Gas using Coke Oven Gas (COG) as feedstock**M. Srinivasarao^{1*}, Nilu Kumar¹, A Syamsundar¹**¹ Research & Development Centre, RINL-Visakhapatnam Steel Plant, Visakhapatnam, AP 530031, India

*srind@vizagsteel.com

Steel making process is energy intensive with specific energy consumption of around 6-6.5 G Cal per ton of crude steel produced. The effective recoveries of waste heat reduce the specific energy consumption and in turn the carbon emissions. During the process of iron and steel making in integrated steel plants, various waste gases and solid wastes are generated at high temperatures. The generated waste gases are utilized as a fuel in reheating furnaces and for power generation. However, in the case of solid wastes such as blast furnace slag and steel slag, the heat is typically not recovered. With a view to utilize this high grade energy, a thermodynamic analysis is carried out in this work to produce synthesis gas (syngas) with CO₂ sorption using hot Linz and Donawitz (LD) steel slag as the heat carrier. Coke oven gas (COG) is used as a feed stock for CO₂ reforming. The thermodynamic equilibrium yields are obtained using Gibbs free energy minimization route. The simulations are carried out at atmospheric pressure over a wide range of operating conditions such as reformer temperature (400-1000°C), CO₂ to COG ratio (CCR=0.5-2), Steel Slag to CO₂ ratio (SSCR=0.5-2.5) to identify the best operating parameters. The study shows that the best operating temperature is 700°C for maximum conversion of CO₂ and also for maximum yield of H₂, at all feed ratios.

359

Reactivity Initiated Transients for 700MWe PHWR**Suresh Kandpal*, M.P.S. Fernando and A.S. Pradhan**

Fuel, Physics, Shielding and Safeguard, Engineering Directorate, NPCIL, Mumbai (INDIA)

*ksuresh@npcil.co.in

Safety analysis for Pressurized Heavy Water Reactor (PHWR) is carried out for various postulated initiating events as per regulatory requirement and may be categorized into normal operation, anticipated operational occurrences and design basis events etc. The analyses of these events are carried out with the objective of verifying that acceptable design limits are not exceeded for these categories. The safety analysis report is made based on the above mentioned analyses. However, certain special transients are also analyzed to confirm the behavior of the reactor during such events to be within acceptable design limits. In present paper, we have analyzed certain reactivity initiated plant transients like loss of regulation (LOR) incident for initial distorted flux shape, local change in reactivity due to pressure tube-calandria tube (PT-CT) break and inadvertent entry of fuel locator into coolant channel for 700 MWe PHWR, which allows boiling at the exit of coolant channel. The above transients have been carried out for the first time for Indian PHWRs with 3 dimensional transient code IQS3D based on improved quasi-static (IQS) approach coupled with thermal hydraulic computer code ATMIKA-T. The analysis results show that fast power rise during transients get terminated by reactor protection system and slow power transients are controlled by Reactor regulation system (RRS) and all safety parameters are within acceptable limits.

360

Multi-Field Solar Thermal Power Plant with Linear Fresnel Reflector and Solar Power Tower**Shridhar Karandikar^{1*} , Irfan Shaikh² , Anish Modi² , Shireesh Kedare² , Balwant Bhasme¹**¹ Mechanical Engineering Department, Sardar Patel College of Engineering, Mumbai, India.² Department of Energy Science and Engineering, Indian Institute of Technology Bombay, Mumbai, India.

*shridharkarandikarssk@gmail.com

The linear Fresnel reflector (LFR) system with direct steam generation (DSG) has lower capital cost owing to flat mirror and less construction requirements. Its optical efficiency, concentration ratio and maximum temperature reached is lower compared to other concentrated solar technologies. The solar power tower (SPT) with molten salts can reach high temperature around 590°C with higher optical efficiency compared to other technologies. But due to high capital costs, commercialization of SPT in India has been limited. Concentrated thermal power plant are cost intensive and so prior to detailed design, it is important to develop conceptual design considering type and size of solar field, site location, power cycle, working temperature and pressure, energy storage, heat transfer fluid, size of power block and economics of project. In this paper, a multi-field collector system configuration with integrated LFR-DSG and SPT-molten salt is proposed. The objective of this work is to compare multi-field configuration with SPT and LFR system on simple techno-economical parameters - solar multiple, storage capacity and their levelized cost of electricity (LCOE). The system is evaluated on hourly basis for a year by means of a simple energy-mass balance code developed in-house. For a 100 MW conceptual multi-field design and 14 hours storage backup, study shows annual energy output of 494 GWh with capacity factor of 56.44 and LCOE of \$0.18 kWh.

361

Influence Of Bed Temperature On Performance Of Silicagel Methanol Adsorption Refrigeration System At Adsorption Equilibrium**Anirban Sur^{1*}, Sanjay Darvekar² , and Swapnil Narkhede³**^{1, 2, 3} Symbiosis Institute of Technology, Symbiosis International (Deemed) University,

Pune, Maharashtra, India

*anirban.sur@sitpune.edu.in

A silica gel–methanol adsorption refrigeration system's performance has been investigated with the help of steady-state mathematical model (D-A Equation) in this study. Under sorption cooling, adsorption refrigeration seems to provide very promising cooling technology in recent years due to the use of environment-friendly refrigerant and simple in operation. Adsorption refrigeration system is attractive because it can run with a low-temperature thermal source (solar energy/ waste heat of heat engine), very less noise, vibration-free operation, and long life. Adsorption refrigeration can be very useful in hot regions where electricity is very scared. Low-grade heat energy (solar/ waste heat) source has been used as input energy. Adsorber's bed temperature has been varied from 65°C to 85°C, and its effect on system performance has been observed by the simulation result generated based on a mathematical model. Programming code has been written in FORTRAN. Observation shows that it can produce a refrigeration effect of 577 kJ with a COP of about 0.33. Although the system performance can

improve with an increase in regeneration temperature in this model. Observation also shows that maximum bed temperature restricted up to 85°C because, after that, system performance reduces.

363

Experimental investigation using enriched biogas in S-I engine for stable rural electrification

P Pallan¹, Deepak Mathew², Yohans Varghese³

^{1,2} Kerala Veterinary and Animal Sciences University, Kerala, INDIA

³ National Institute of Technology, Kerala, INDIA.

The experimental work focus to convert harmful GHGs (CH₄) in to moderate GHG S (CO₂) by means of energy exchange. Biogas produced from large scale floating drum plant is purified and fed into gasoline engine in varying and fixed ratios. The output power and the exhaust emission were analyzed by various techniques like variation in electric load and exhaust gas analyzer etc. The biogas input to the engine was facilitated through an external flange arrangement. Maximum loading condition of 540 watts at a voltage of (227.777 ± 5.08478 V) and the engine frequency of (47.3121 ± 0.48296 Hz) obtained, when the input concentration is enriched biogas (90% CH₄ and 10% CO₂). The engine conversion of the hydro carbon beyond the 70% CH₄ concentration limit was found to remain stagnant. A higher methane concentration does not result in a higher CH₄ conversion instead it resulted in a partial conversion with higher Carbon Monoxide (CO) production. In the case of emissions, minimum CO level was registered for 70% CH₄ and maximum for 90%, so it can be concluded that enrichment beyond 70% methane in biogas mixture tends to enhance CO level at outlet.

364

Solar autoclave for rural hospitals using aerogel as transparent insulation material

Manoj Kumar Yadav*, Anish Modi and Shireesh B Kedare

Department of Energy Science and Engineering, Indian Institute of Technology Bombay, Powai, Mumbai 400076, Maharashtra, India

*manojyadav@iitb.ac.in

An autoclave is a device which is used to sterilize surgical instrument in hospitals. Shortage of electrical power supply in rural hospitals and pollution due to fossil fuel leads people to find other power sources to run autoclave. The solar autoclave can be used in those places. At present, no commercial solar autoclave is available in the market. Many researchers have developed solar autoclave but most of them needed tracking which makes them costly. This paper presents a non-tracking solar autoclave which uses compound parabolic concentrator to concentrate diluted sunlight and optically transparent and thermally insulating aerogel to reduce thermal losses from receiver surface. The collector was designed, fabricated and experimented for sterilization purpose by using sterilization load requirements form nearby hospitals. The experiment shows that the aerogel collector with compound parabolic concentrator and polycarbonate sheet can generate saturated steam for sterilization.

368

Comparative Evaluation of Direct Matrix Converter Using IGBT and Power MOSFETs**Maheswari K.T.^{1*}, Bharanikumar R^{2#}.**¹Department of EEE, Bannari Amman Institute of Technology, Tamilnadu, India.²Department of EEE, Bannari Amman Institute of Technology, Tamilnadu, India.

*maheswarikt@bitsathy.ac.in, #bharanikumarr@bitsathy.ac.in

Nowadays, the rapid improvement in power semiconductor devices has gained more attention in Power Electronics. This paper deals with the quantitative investigation on Direct Matrix Converter employing both IGBT and MOSFET for high efficiency converters. The result shows that the IGBT has significantly less switching loss than MOSFET. Furthermore, for high operating temperature, the switching loss will increase appreciably for MOSFET while in the case of IGBT switching loss has only little variation over temperature. The performance of IGBT and MOSFET are evaluated by conducting the comparative analysis of switching power loss, temperature, volume, weight requirements, power quality, efficiency and static characteristics. By comparing the device parameters, it has been concluded that IGBT provides the superior advantages of smaller loss, better efficiency and small size than MOSFET.

369

Numerical investigation on the influence of reactant gas concentration on the performance of a PEM fuel cell**Brajesh Kumar Kanchan^{1#}, Pitambar R. Randive^{2*} and Sukumar Pati^{3**} [3842-242273]**^{1,2,3} Department of Mechanical Engineering, National Institute of Technology Silchar, 788010, India

#brajeshlean@gmail.com, * kp691975@gmail.com, **sukumar@mech.nits.ac.in

The present study numerically investigates the influence of reactant gas concentration on the performance characteristics of a proton exchange membrane (PEM) fuel cell. The effect of reactant gas configurations of the electrodes is discussed in terms of performance characteristics viz. cathode water concentration, current density, power density, and overpotential. Our study reveals that cathode water concentration, current density and subsequently power density has a linear relationship with the concentration of reactant gases. It is found that the cell performance becomes superior with an increase in the concentration of reactant gases. Furthermore, overpotential is observed to be minimum at higher concentrations of reactant gases. The findings of this study bear utility towards designing an efficient PEM fuel cell system that can deliver a higher power density, current density with minimal overpotential.

370

Energy Efficiency Analyses of a Building Envelope: A Case Study**M. Y. Khan^{1*}, A Baqi¹ and A Talib²**¹ Aligarh Muslim University, Aligarh UP 202002, India² Indian Institute of Science, Bangalore KA 560012, India

*yasirkhan2808@gmail.com

The improvement in thermal comfort of a building passively helps in reducing its energy utilization, throughout the year. Several factors are directly related to reducing the cooling and heating load of the building such as orientation and the material used in it. In this study, authors have proposed a new wall & roof panel system namely Ferro Cellular lightweight-concrete Insulated Panel Assembly (FCIPA) for a building. This panel system has been tested experimentally in direct axial compression and is compared with brick masonry wall at small scale. Further, it has been tested theoretically for thermal analysis using eQUEST energy simulation program. The thermal study was conducted on an existing residential building of New Delhi, India, by changing the components of wall and roof of the building with three different kinds of construction material namely brick, concrete, and FCIPA. Moreover, the effect of orientation and the type of window glass on the thermal efficiency of the building were also studied. It was found that the FCIPA has the load-bearing capacity equivalent to half brick thick (120mm) masonry wall. In addition, in terms of the energy use, FCIPA based building consumes nearly half of the thermal energy to that of the precast concrete and brick masonry based buildings. The results of the theoretical analysis also show that the north-south orientated building with longer axis running towards east-west having grey glasses window/doors openings is the most energy efficient.

372

Design and Analysis of a Solid Oxide Electrolyser Plant for the production of Ammonia from Excess Renewable Electricity
Vishnu Dev^{1*}, Nemechie Lawson¹, Danjal Togard¹, and Ning Zhang¹
¹ Department of Mechanical Engineering, Denmark Technical University, Lyngby, Copenhagen

^{*}s181255@student.dtu.dk

A Solid Oxide Electrolyser Cell plant producing ammonia was modelled with specific design conditions. This study adopted the case study of wind energy produced in Faroe Islands. The model was simulated for a varying stack amount with a range of power inputs. It was observed that the rate of ammonia production (in terms of mean molar fraction) is independent of the number of stacks, provided that the power input is within the operating range of each design. It was inferred from the results that installing an SOEC plant with 700 stacks (with 75 cells in each stack) along with an operation time of 4000 to 8000 hours, can reduce the demand for gasoline in the transportation sector by approximately 5.5% to 14.7%. The possibility of utilizing the excess heat from the SOEC plant was investigated. However simulation results showed that recovering heat from ammonia production for district heating was not a viable solution. A sensitivity analysis showed that for a given power input, the production of ammonia increases with an increase in pressure inside the ammonia reactor and decreases with the increase of the outlet temperature of the reactor. For peak ammonia production, the reactor must have an inlet temperature of 750°C with an outlet temperature of 450°C and an operational pressure of 300 bar.

374

Recovery & Utilization of Heat Energy Wasted Through Hot Kiln Surface in Cement Plant
Ankur Mittal^{*}, Ashutosh Saxena, Bibekananda Mohapatra

National Council for Cement and Building Materials, Ballabgarh (HR)-121004

*ankurmittal82@gmail.com

India is the second largest cement producer in the world after China and it has evolved to become one of the best in terms of energy efficiency, quality control and environment improvement. The current installed capacity of cement industry in India is 509 million tonnes. Indian cement industry is continuously adopting conventional as well as advanced energy saving measures. Indian cement industry is equally giving thrust to replace fossil fuel based energy usage by renewable energy sources like wind mill, solar PV system etc. Apart from energy efficiency, energy optimization and renewable energy usage, there is a great scope of making utilization of energy available in waste process flue gases and radiation energy from rotary kiln shell (High surface temperature). Adoption of Waste Heat Recovery (WHR) systems in Indian cement manufacturing facilities has gained a lot of momentum during the past decade. There are several heat losses associated from clinker production process. High temperature heat is directly dissipated into atmosphere in the form of flue gases and radiation. For heat recovery from hot flue gases, a lot of work has already been done and presently total installed capacity of WHRS installed using hot kiln flue gases is 344 MW (2017). Many case studies and optimization techniques are available for further optimization of WHRS through process flue gases. A significant potential rests for utilization of kiln waste radiation energy (emitted from hot rotary kiln surface) which is under exploration for feasibility. A great potential (3.9 % or ~30 kCal/kg clinker) rests with radiation energy from rotary kiln surface. There is no such example of currently operational facility in Indian cement plant under waste heat recovery from kiln shell radiation energy. Under this condition, it becomes a great area to study the feasibility of waste energy utilization. The recovered energy can be used either for electricity generation or preheating raw meal or primary combustion air.

376

Analytical Modeling of Solar Photovoltaic System under Partial Shaded Condition

Ch. Santhan Kumar^{1#}, R. Srinivasa Rao^{2*}, K.Kalyan Raj^{3}**

¹Department of Electrical and Electronics Engineering, BIET, Hyderabad, INDIA

²Department of Electrical and Electronics Engineering, JNTUK, INDIA

³Department of Electrical and Electronics Engineering, GEC, INDIA

#wizitcsk@gmail.com, *srinivas.jntueee@gmail.com, **kalyan20.kaniganti@gmail.com

Photovoltaic systems are subjected to several environmental disturbances, one such a disturbance is partial shading, which adversely affects the performance of the photovoltaic system. Therefore, there is a need to develop a complete analytical model of PV system under Partial Shading Condition to investigate the most suitable Maximum Power Point Tracking method under these conditions. Following these requirements, an accurate analytical model of Photovoltaic system under partially shaded condition considering the effect of both series and shunt resistance is developed. The effects of temperature changes, irradiation changes and partially shaded condition on electrical characteristics of the PV array are also examined. The results proved that the reliability of the proposed model is good, and it can be used to model different ranges of Photovoltaic system for both standalone and grid-integrated systems.

378

Analysis of currency note paper and banana fiber pulp waste utilization and its effect of density, moisture and temperature on wood products**Dr. Ashok G. Matani^{1*}, Dr.S. K. Doifode^{2**}, Premesh P. Bhatkar^{3#}**¹Department of Mechanical Engineering, Government College of Engineering, Amravati, India²Government College of Engineering, Amravati-444604[MS] India,³Mechanical Engineering, Government College of Engineering, Amravati- 444604 [M.S.],India, *dragmatani@gmail.com

,**shamal_doifode123@gmail.com, #premesh.bhatkar0612@gmail.com

There are many energy sources like oil, natural gases, wind, water, and many more that can all be applied in different ways. Banana is one of the important fruit crops cultivate in tropical part of the world. Banana farming generate huge quantity of biomass all of which goes as wastage and the above ground part like pseudo-stem and peduncle are the major sources of fibers. Banana fiber can be used as raw material for industry for production of range of products like paper, cardboards, tea bags, currency notes and reinforced as polymer composite in high quality dress materials. Cellulose is the major component of the fiber. Today engineering industries are seeking to produce eco-friendly materials. Natural fibers have distinct properties like high strength, low weight, low cost processing and biodegradability than synthetic fibers such as glass fiber and carbon fiber.

383

Optimizing rotavator design towards minimizing water consumption and increased crop productivity in agriculture**Dr. Ashok G. Matani^{1*}, Ankush D. Bhishnurkar^{2**}, Dr.S. K. Doifode^{3#}**¹Professor, Department of Mechanical Engineering, Government College of Engineering, Amravati, India.²Assistant Professor, G. H. Raisoni Institute of Engineering & Management, Jalgaon, [M.S.] India.³Government College of Engineering, Amravati-444604[MS] India.

*dragmatani@gmail.com, **anky4589@gmail.com, #shamal_doifode123@gmail.com

Continuous use of acid-forming nitrogen fertilizers causes a decrease in soil pH, liming, if not carried to prevent the declining efficiency of field crops. Soil health management is crucial for ensuring sustainable agricultural productions and maintenance of biodiversity. In recent years, fertilizer consumption increased exponentially throughout the world, causes serious environmental problems. Fertilization may affect the accumulation of heavy metals in soil and plant system. Plants absorb the fertilizers through the soil; they can enter the food chain. Rotavator can play an important role in double or multiple cropping systems where the time for land preparation is very less or limited. Rotavator is the best option available to achieve this landmark as it is already proved that seedbed prepared by using rotavator gives highest benefit to cost ratio. It is also proved that use of rotavator for seedbed preparation also saves time and money compared to other method such as use of cultivator or manually seedbed preparation done.

384	Inkjet-Printed Nanostructured Thin Film Electrodes for PEM Fuel Cell
------------	---

Khantesh Agrawal* and Venugopal Santhanam

Department of Chemical Engineering, Indian Institute of Science (IISc), Bangalore, Karnataka, India

*agrawal@iisc.ac.in

Proton exchange membrane fuel cells (PEMFCs) are an energy-efficient alternative to combustion engines for automotive applications but are still on the cusp of mass-production, mainly due to higher costs. Significant advances have been made in PEMFC system design over the last three decades concerning cost-reduction and structural redesign. The membrane electrode assembly (MEA), especially the electrode, is considered as 'the heart' of a PEMFC and is designed to accommodate constraints imposed by the cost of platinum used for electrocatalysis, as well as the need for efficient transport of electrons, reactants, and heat. Consequently, the structure and composition of the 'electrode' have been significantly altered over the years, from utilizing Pt black films with a Pt loading of 10 gpt/cm² in the 1970s to present-day Pt/ PGM (Platinum Group Metal) nanoparticle coated carbon black particles (Pt/C) that use about 0.3 mgpt/cm². The electrocatalyst architecture based on highly dispersed nanoparticles on carbon black particles enables significant gain in specific surface area of the catalyst. However, concomitant durability problems associated with corrodible carbon support and loss of active surface area under PEMFC working conditions; especially during start-up or shut down cycles have led to renewed interest in carbon-free nanostructured electrodes. These employ a thin coating of Pt or PGM based catalytic layer on mesostructured conductive support to fabricate nanostructured thin film electrodes (NSTFs) . However, the requirement of sophisticated instrumentations and setups like cleanroom or vacuum deposition for the NSTF fabrication process allows the scope of further improvement for developing simpler and cost-effective additive fabrication processes along with the further reduction in Pt/PGM loading of electrodes. In this context, Print-Expose-Develop technique developed in our group was used to fabricate porously and conducting silver nanostructures on Nafion membrane to be used as a backbone of a carbonless electrocatalyst. Preliminary results confirm successful electrodeposition, of Pt on metallic nanostructures with the loading of < 10 µgPt/cm² using a self-terminating process . The ease of printing silver nanostructures using a simple inkjet printer and the ability to coat them with atomic layers of Pt via cycling of electrode potential can pave the way for cost-effective, additive process for manufacturing of MEAs for PEMFCs.

385	A graphical dual objective approach for minimizing energy consumption production planning under uncertainties
------------	--

Rakesh Kumar Sinha, Nitin Dutt Chaturvedi

Department of Chemical and Biochemical Engineering, Indian Institute of Technology Patna, Bihta, Patna, 801106, Bihar, India

Carbon emission and energy consumption are two important factors need to be addressed while production planning for sustainable development. As the population is increasing and demand of various commodity is increasing rapidly; therefore, production planning is required which reduces the environmental effect, improves energy efficiency and also meet the forecasted demand. In this work, two objectives carbon emission and energy consumption are taken in parallel consideration and methodology is proposed for production planning via existing and

new process routes for minimizing one objective while imposing a maximum limit on the other objective. In many situations the demand, energy consumption and carbon emission may not be deterministic in nature due to environmental and operational changes. The proposed methodology is capable of incorporating uncertainties with the production parameters. The proposed methodology is graphical and based on the concepts of pinch analysis that gives physical insight to the problem. Current production scenario utilizes existing process routes and to meet the future demand new process routes (based on best available techniques) are to be added. Production planning is to be calculated via each process route in order to minimize energy consumption and carbon emission. The stochastic constraints, due to uncertainties that correspond to flow and quality parameters of the resources are transformed to deterministic equivalents by utilization of chance-constrained. Thus, proposed methodology provides flexibility to the planner to consider either of the two cases based on uncertainties and it reduces the excess burden of carbon emission and energy consumption while satisfying the demand.

386	Photovoltaic performance of PbS Quantum dot solar cells
------------	--

Sandeep kumar^{1*}, and Basudev Pradhan^{1,2}

¹New Generation Photovoltaic Research Laboratory, Department of Energy Engineering, Central University of Jharkhand, Ranchi, India

²Centre for Excellence (CoE) in Green and Efficient Energy Technology (GEET), Central University of Jharkhand, Ranchi, India.

*sdp5064@gmail.com

PbS quantum dot (QD) based thin film solar cells have attracted a great deal of research interest in recent years due to simple, low cost, large area processability, high throughput, and cost effective solar energy conversion. In this work we have synthesized PbS colloidal QDs with appropriate band gap to absorb infrared light in the solar spectrum. The different optical and electrical characterizations of as synthesized PbS QDs in solution as well as in thin film have been studied. PbS QD thin films have been deposited by solid state ligand exchange using Tetrabutylammonium Iodide (TBAI) and Ethanedithiol (EDT) organic ligands. Solar cells have been fabricated in different heterojunction structures and their photovoltaic performances have been investigated. A comparative study of these architectures offer us greater insight for fabrication of low cost, air stable PbS QDs based thin film solar cells.

387	Enhancing the capacity of sustainable biowaste dual doped activated carbon by “inner sphere mechanism” of redox active electrolyte
------------	---

Bhumika, Raj Kishore Sharma* and Gurmeet Singh**

Department of Chemistry, University of Delhi, Delhi-110007, INDIA

*drrajksharma@yahoo.co.in, **gurmeet123@yahoo.com

Combinatorial approaches of heteroatom doping in carbon nanostructure and utilization of redox mediated electrolyte enhances the electrochemical properties of supercapacitor.1,2 Considering both effects, herein, a nitrogen-phosphorus dual doped 3,4 (AC-NP) biomass derived activated carbon (AC) electrode in redox active electrolyte [hydroquinone (HQ)] is fabricated for energy storage. AC-NP not only possess sheet like structure (~250 nm length) with abundant macropores, but also acquire effective doping of nitrogen (32%) and phosphorus

(68%) which is advantageous to improve the rate performance of supercapacitor. Owing to the redox reactions of HQ/Q, AC electrode shows highest specific capacitance of 1518.46 F g⁻¹ in 0.38M HQ/H₂SO₄, making 0.38M the optimal concentration for HQ in 1 M H₂SO₄. Therefore, synergistic interaction of redox mediated electrolyte and heteroatoms in carbon lattice, lead to impressive performance of AC-NP||AC-NP (611.03 F g⁻¹ @ 2 A g⁻¹) which is five times higher than those of the pristine H₂SO₄ and twice than re doped activated carbon (AC||AC) in HQ/H₂SO₄. Furthermore, AC-NP||AC-NP shows phenomenal increase in energy density (69.47 Wh kg⁻¹ @ 904.72 W kg⁻¹) compared to AC||AC (31.5 Wh kg⁻¹ @ 972 W kg⁻¹). A reasonably good initial capacitance retention (70%) was observed after 5000th cycles. The improved performance of AC-NP||AC-NP is attributed to the electron donor properties of heteroatoms and oxidation/reduction of HQ that induces pseudocapacitance by reversible faradaic reactions. Thus, synergistic interplay of pseudocapacitance with diffusion-controlled faradaic reactions of HQ/Q transformations make AC-NP a highly electroactive material for high energy density supercapacitor.

Therefore, this strategy provides a versatile method for designing new energy storage devices for the development of high-performance supercapacitors.

388

Synthesis and Performance of Proton Conducting Novel Sulfonated Poly(Oxybenzimidazole)-Graphene Oxide Intercalated Composite Membranes for PEM-Fuel Cells

Cheluri Nagendra Prasad *, Tharanikkarasu Kannan

Department of Chemistry, Pondicherry University, Pondicherry - 605014, India.

*cnp.org.chem@gmail.com

The most attractive Proton exchange membrane fuel cells (PEMFCs) are considered as powerful green energy sources for portable, stationary and transport applications because of clean, quiet and eco-friendly nature¹. Until now, among the PEMs Nafion is the state-of-the-art PEM due to its good thermal and chemical stabilities, superior mechanical properties as well as high proton conduction ability. However, Nafion exhibits some drawbacks such as high cost, fuel crossover, low proton conductivity at elevated temperature. In view of this, tremendous efforts have been explored to the modification of Nafion or development of alternative membrane materials including, sulfonated polyimides (SPIs), sulfonated poly(arylene ether)s (SPAEs), sulfonated polybenzimidazoles (SPBIs) and their composites are the focus of current investigations on PEMs. Currently, GO is highly attractive for many applications as a result of outstanding thermal and mechanical properties. In the present work, the novel SPOBI-60 was synthesized via copolycondensation and a series of corresponding composites with different contents of a graphene oxide (GO) were prepared in order to study the effects of GO content on the SPOBI-membranes properties. Our investigation revealed a structural reorganization in the composite, showing clearly that the incorporation of the proper amount of GO in SPOBI-60 enhanced the thermal, oxidative hydrolytic stabilities, mechanical properties, and increased the proton conductivity and power density and current density values (i.e., PEM fuel cell performance) as comparable to that of Nafion-117. Finally the results obtained from our studies are indicated that the synthesized membranes were expected to be new options as promising PEM materials in fuel cell technology.

389

Carbon and MOF based Composite Polymer Electrolyte Membranes: A Pathway to Energy Application**Swati Gahlot***

*gahlot.swati20@gmail.com

Fuel cell, batteries etc. are the kind of devices that are replacing conventional sources of energy. Polymer electrolyte membrane (PEM) is the heart of polymer electrolyte membrane fuel cell (PEMFC) as well as Vanadium Redox Battery (VRB) since the ion transport across the membrane is the key property in shaping the final performance. Emphasizing on the low cost and high performance, researchers all over the world are developing new composite membranes. In the present work, carbon based materials (graphene oxide, sulfonated graphene oxide) as well as metal organic framework (MOF) have been used as fillers for composite membranes preparation. Sulfonated poly ether sulfone (SPES) has been used as polymer matrix to prepare the composite membranes since SPES possesses good film forming properties with high electrochemical performance. Membranes have been synthesized containing various concentration of fillers through simple solution casting method. Ionic conductivity, ion exchange capacity etc. electrochemical property of composite membranes has been investigated. Prepared membranes exhibits good thermal and mechanical properties. Membrane methanol permeability has been analyzed for fuel cell while vanadium permeability has been evaluated for VRB in a two compartment cell. Composite membranes demonstrate effective performance and responsible for improved selectivity and reduced fuel crossover across the membranes.

390

Dielectric-Meta material Antireflection Coating for efficient transmission enhancement in CZTS/CdS Solar cell**K.S. Joseph Wilson*, M. Ismail Fathima, Zaheetha banu,**

Department of Physics, Arul Anandar College (Autonomous),

Karumathur, Madurai – 625 514, India

*wilsonpra@yahoo.co.in

The effective optical properties of artificial meta materials perform very essential role to reduce the reflective losses in the highly efficient solar cell. Recent designs of Dielectric – Metamaterial composite have some advantages in improving the coupling effect of light in the visible region. It has been established that the Dielectric – Metamaterial Antireflection coating (DMARC) produce outstanding results. It drastically reduces the reflection and enhances the transmission over a various angle of incidence, in the visible region. Present theoretical work revealed that the transmission effect with various dielectric substrates such as MgO/SiO₂/TiO₂/ZnO with Ag-MgF₂-Ag DMARC on CZTS/CdS Solar cell. This system may also be analysed with different incident angles using Transfer matrix method (TMM). It is found that solar cell with ZnO with Ag-MgF₂-Ag DMARC provide the maximum light transmission in visible region at normal incidence. It is also found that the ZnO with Ag-MgF₂-Ag ARC design on CZTS/CdS Solar cell can lead to improve the quantum efficiency from 3.5 % to 22% at 400nm-700nm.

391

Tapered Manifold for Electrolyte Circulation in Vanadium Redox Flow Battery**Praphulla Rao, Ravendra Gundlapalli, Sreenivas Jayanti**

Department of Chemical Engineering, IIT Madras, Chennai 600036, India

Manifolds are used to distribute a large fluid stream to many small streams of fluids by branching. Flow batteries contain many cells through which the electrolyte need to be circulated. Since all cells are designed and manufactured as per an identical protocol, they need equal flow rate of the electrolytes. It is therefore necessary to distribute electrolyte equally. Improper distribution leads to sub-optimal performance and can contribute to shunt current losses. In the present work, we study the effectiveness of a tapered manifold in distributing electrolyte to cells connected in series in the form of a stack. An acrylic sheet with 12 mm thickness has been used for the construction of a planar, tapering manifold with reducing area of cross-section in the flow direction. This material can withstand the acidic vanadium electrolyte. Cross sectional area is changed from 24 cm² to 9 cm² and the manifold has one inlet of 12 mm diameter and eight outlets of 6 mm diameter each which are set apart at equal intervals of length. Preliminary experiments of flow distribution were carried out by fixing identical lengths of outlet tubing of 4 mm inner diameter. By changing the length, the pressure suffered by the flow downstream of the header can be varied. Flow measurements were done at different pressure drops to understand the flow distribution. For given inlet flow rate of water, pressure drop and flow rate of each outlet are measured. The percentage absolute mean deviation for the tapered manifold was found to be 6%. Further experiments have been carried out by connecting the header to a vanadium redox flow battery (VRFB) stack of eight cells, each cell having an active area of 1500 cm². Measurements confirm that fairly even distribution of the manifold-fed through each cell of the stack. The results confirm that tapered manifolds are suitable for the even circulation of electrolyte in vanadium redox flow battery. Further work on scaling up is being carried out with the help of computational fluid dynamics simulations.

395

Electrodeposition of MoS₂ on Three-dimensional Graphene/Nickel Foam for Electrocatalytic Water Splitting**R. Narasimman^{1*}, Manmohansingh Waldiya², Indrajit Mukhopadhyay^{2,3} and Abhijit Ray^{2,3}**¹Advanced Power Systems Division, Chemical Systems Group, Vikram Sarabhai Space Centre, Thiruvananthapuram – 695 022, Kerala, India²Solar Research and Development Centre, Pandit Deendayal Petroleum University, Gandhinagar – 382 007, Gujarat, India³Department of Solar Energy, School of Technology, Pandit Deendayal Petroleum University, Gandhinagar – 382 007, Gujarat, India

Rapidly depleting fossil fuel and CO₂ emission from the utilization of fossil fuels lead to the development of sustainable, clean and renewable alternate energy sources. Hydrogen is considered as a suitable candidate because it is having high energy density and zero gas emission. Among the various methods of production of hydrogen, hydrogen evolution reaction

(HER) in electrochemical water splitting is considered as the most promising and environmentally friendly approach. Noble metals like Pt, Pd, etc., are known to effectively catalyze the HER, however, scarcity and high-price is restricting the large-scale production of hydrogen. Transition metal dichalcogenides (TMDC) such as MoS₂, WS₂ are widely studied electrocatalysts for HER in acidic medium. Also, three-dimensional (3D) electrodes are advantageous because of the porous and interconnected structure which increases the surface area and effective mass transport. In this study, we have electrodeposited MoS₂ on to the graphene coated nickel foam (graphene/nickel foam). Graphene/nickel foam was prepared by APCVD technique at 850°C. The graphene was coated uniformly on nickel foam and it consists of 5-8 layers. The graphene/nickel foam was used as the electrode for the electrochemical deposition of MoS₂. The cathodic electrodeposition of MoS₂ on graphene/nickel foam was carried out by applying the potential of -1.2 V (vs. Ag/AgCl) for 20 mins. The morphology was evaluated by scanning electron microscopy and formation of MoS₂ was confirmed by Raman spectroscopy. Freshly prepared samples were evaluated for HER in 0.5 M H₂SO₄ by linear sweep voltammetry, Tafel slope and electrochemical impedance study. MoS₂ coated graphene/nickel foam showed the overpotential of 180 mV, Tafel slope of 70 mV/dec and charge-transfer resistance of 15 ohm. The electrode was stable in the acidic medium and electrocatalytic activity was maintained for more than 16 h.

399

Conductivity studies of Mg-ion conducting PC-DEC doped PEO polymer gel electrolyte membrane
C.Maheshwaran^a, Poonam Sharma^b, D.K.Kanchan^a
^aDepartment of Physics, Faculty of Science The M.S University of Baroda Vadodara 390002, Gujarat, India

^bSchool of Science, GSFC University, Fertilizer Nagar, Vadodara, Gujarat, India

Magnesium ion conducting PEO polymer gel electrolyte membranes with PC-DEC have been prepared by standard solution casting technique. The conductivity analysis reveals that PEO;MgTf polymer electrolyte membrane with 15% of PC-DEC polymer electrolyte exhibits the maximum ionic conductivity of the order of 10⁻⁵ S cm⁻¹. The temperature dependence of ionic conductivity for all composition of PEO: MgTf: PC-DEC polymer films obey Arrhenius relation. Differential scanning calorimeter (DSC), X-ray diffraction (XRD), Scanning electron microscopy, Atomic force microscopy (AFM), cyclic voltammetry (CV) Fourier Transform Infrared spectroscopy (FTIR) techniques are employed to study the influence of cation-polymer interactions on structural and electrochemical properties of the prepared polymer gel electrolyte films. Mg⁺ ion conduction in the polymer electrolyte film is confirmed from the cyclic voltammetry studies.

401

A comparative study of hydrogen uptake capacity using physisorption mechanism in carbon based materials**Shrilekha V. Sawant^{1*}, Seemita Banerjee², Ashwin W. Patwardhan¹, Jyeshtharaj B. Joshi^{1,4} and Kinshuk Dasgupta^{3,4}**¹Department of Chemical Engineering, Institute of Chemical Technology, Mumbai 400019, India²Chemistry Division, Bhabha Atomic Research Center, Mumbai 400085, India³Mechanical Metallurgy Division, Materials Group, Bhabha Atomic Research Center, Mumbai 400085, India⁴Homi Bhabha National Institute, Anushaktinagar, Mumbai 400094, India

*shrilekhasawant22@gmail.com

For practical application, US DOE has set the target for hydrogen storage which includes gravimetric and volumetric hydrogen storage capacity of 5.5 wt% and 40 g.L⁻¹ respectively at an operating temperature of -40 to 60°C under maximum delivery pressure of 12 bar. Material based, specifically doped carbon nanotubes based upon physisorption mechanism were considered in present study. Physisorption processes are easy to handle, reversible with low activation energy and possess fast adsorption-desorption kinetics. Boron and nitrogen codoped carbon nanotubes (b,N-CNTs) were synthesized by chemical vapor deposition using ethanol, ferrocene, imidazole and boric acid as carbon source, catalyst precursor, nitrogen precursor and boron precursor respectively. The B,N-CNTs were characterized by electron microscopic analysis, X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, thermogravimetric analysis (TGA), etc. The nitrogen and boron content was 1.5 and 1.34 at% respectively. At pressure 16 bar, 1.96 wt% and 0.35 wt% of hydrogen storage was reported at 77 K and 303 K respectively. The obtained data was compared to the available literature data, for more insight into heteroatom doping in hydrogen storage. The p-type doping (boron) and n-type doping (nitrogen) helped in higher hydrogen storage due to synergistic effects.

402

Effect of Flow Velocity on the Performance of the Savonius Hydrokinetic Turbine**Vimal Patel^{1*} and Kushal Shah²**

1, 2 Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, INDIA

*vimal.iitbombay@gmail.com

The use of hydrokinetic turbine gathers much attention due to its high power density compared to wind turbine and predictable power output. The Savonius turbine is one of the best hydrokinetic turbines, however, limitation with low coefficient of power. The input velocity to the turbine also plays important role on the performance of the turbine. In the present investigation, the effect of flow velocity on the performance of the Savonius turbine is investigated with numerical simulation. The grid independent study, domain optimization and validation of the methodology used in the present investigation is carried out prior to the investigation. The investigations are carried out for different 10 inlet velocities and performance of the turbine is compared in form of coefficient of power (C_p). The results indicates that, to get optimum performance from the turbine minimum 2 m/s velocity is required for the considered design of the turbine.

404	Experiment Study on Laboratory scale Open Cycle OTEC power module
------------	--

Anand Mani, Karthikeyan A, Narasimha Rao Y V, Ajai Babu, Biren Pattanaik*, Prasad Vinayak Dudhgaonkar, Purnima Jalihal

National Institute of Ocean Technology, Chennai

*biren.niot@gov.in

Ocean Thermal Energy Conversion (OTEC) and Low Temperature Thermal Desalination (LTTD) processes utilize the temperature difference between warm surface ocean water and cold deep ocean water to generate electricity and fresh water respectively. India is a tropical country with the temperature gradient of 20C available between warm surface ocean water and cold deep ocean water throughout the year. National Institute of Ocean Technology (NIOT) has successfully established LTTD plants at Kavaratti, Minicoy and Agatti islands by utilizing temperature gradient in the ocean. All three plants are continuously supplying potable water where as in these islands alternative source of drinking water is not available. In view of increasing demand for drinking water, upon request from U.T. Lakshadweep Administration NIOT is setting up an open cycle OTEC plant in Kavaratti which will have a desalination capacity of 1 lakh liters per day. However electricity generation using OTEC has many technical challenges to overcome. NIOT has built a state-of-the-art laboratory scale OTEC-LTTD laboratory for research and development purpose at its premises in Chennai.

This OTEC-LTTD laboratory setup is the first of its kind in India while only a few places around the world are engaged in research in OTEC.

405	Investigation of Vanadium Redox Flow Battery
------------	---

Anand Kumar Tripathi¹ and Prof. Manoj Neergat²

^{1,2} Department of Energy Science and Engineering, Indian Institute of Technology Bombay

¹anandtripathi@iitb.ac.in

Improvement in catalytic activity of pre-treated carbon felt (thermal, electrochemical and acid treated) relative to that of the untreated carbon felt toward redox reactions relevant to vanadium redox flow battery (VRFB) performance is widely reported in the literature and the obtained power density is mentioned in terms of surface area (cm²). However, the baseline for the electrode materials is still the point of investigation. In this work, the origin of such activity enhancement due to pre-treatment and in-situ treatment (charge-discharge cycles) of carbon felts is investigated. The performance curve of the VRFB shows that there is no substantial effect of pre-treatment since pristine carbon felt undergoing charge-discharge cycles itself can deliver the same performance in VRFB. Both show approximately same performance. Effect of gasket thickness on the performance of VRFB has also been studied and it suggest that carbon felt compressed to 22% give more power density than that of the electrode compressed to 6%. Therefore, porosity as well as volume of electrode has a crucial role in the performance. Therefore, the performance must be expressed on a per unit volume (cm³) basis rather the surface area (cm²). In this study, compression of carbon felt electrodes is optimised and tested in a VRFB system. Maximum power density of 375 mW cm⁻² was obtained at a flow rate of 150 mL min⁻¹ with the 22% cell compression, combined with a Nafion-117 membrane.

410

Comparison of catalytic activity towards Hydrogen evolution reaction for different MoS₂ catalysts**Debittree Choudhury* and Prof. Manoj Neergat****

Department of Energy Science and Engineering, Indian Institute of Technology Bombay

*debittree95@gmail.com, ** nmanoj@iitb.ac.in

Hydrogen evolution has long been counted as a greener, emission free and efficient source of energy production. Precious metal catalysts, such as Pt or Pd are used as conventional HER catalysts. But the high cost and rarity of these metals drive the choice of catalysts towards non precious metal catalysts (NPMCs) such as molybdenum disulphide. A unique property of MoS₂ is achieving different structures under different synthesis conditions. Layered molybdenum disulfide has been proved to be the mostly active catalyst towards HER with its optimized layer distance and highly active edge sites. Different MoS₂ catalysts are synthesized at different conditions using conventional wet chemical synthesis and hydrothermal method. The phase formation was confirmed via XRD and, the surface morphology and structure was examined using SEM and TEM. Electrochemical activity was investigated by cyclic voltammetry (CV) in 0.5 M H₂SO₄ in a three electrode rotating disk electrode (RDE) configuration. Both the HER activity and electrochemical stability is higher in case of layered sample instead of amorphous or commercial MoS₂ samples.

411

Front-contact Metallization of Silicon Photovoltaic Cell**Divya Priyadarshani*, Manoj Neergat****

Indian Institute of Technology Bombay (IITB), Mumbai-400076, India

*divyapriyadarshani@iitb.ac.in, **nmanoj@iitb.ac.in

Silver (Ag) screen printing is the commercialized technology for the front-contact metallization. On the other hand, silver screen printing causes Si wafer breakage and results in conversion loss and poor aspect ratio. Copper is an alternate option for the front contact as its conductivity is comparable to that of silver [1]. However, copper has a tendency to diffuse through Si and create recombination sites. To avoid diffusion of copper in silicon, Ni is usually deposited as a barrier layer. In this work, Ni thin-films are deposited on Si by light induced plating (LIP). Nickel films are annealed to promote adhesion. Conditions to get the desired phase of nickel silicide (NiSi) are optimized. In-situ XRD is carried out to analyze the phase of the nickel silicide films (Figure 1). The quality of the Ni film deposited by LIP is compared to the Ni film deposited by electroless method. NiSi phase formation is observed in case of nickel deposited by electroless method and annealed at ~500° C for 15 min. For the nickel deposited by LIP and annealed at ~500° C for 15 min, few low-intensity peaks are observed. Moreover, Mott-Schottky analysis is carried out to investigate the interface properties.

412

Electrochemical characterization of platinum poly crystalline nanoparticles in chloride ion contaminated electrolytes and the recovery of active sites**Rajan Maurya^{1*}, Manoj Neergat^{2**}**

1, 2 Indian Institute of Technology Bombay, Powai 400076, Mumbai, India

*rajan.maurya@iitb.ac.in,**nmanoj@iitb.ac.in

Platinum (Pt) is a precious metal which catalyze numerous electrochemical reactions such as oxygen reduction reaction (ORR) and hydrogen evolution reaction (HER) in fuel cells, batteries etc. Efficiency of fuel cell depends upon electrocatalysts, which in turn depends on the catalyst surface structure and its cleanliness. In the present work, carbon supported polycrystalline platinum (Pt PC) is electro chemically characterized using cyclic voltamm etry (and electrochemical impedance spectroscopy (EIS) in chloride ion (Ca Cl 2 of different concentrations (5×10^{-4} M, 1×10^{-3} M) contaminated 0.5 M H₂SO₄ electrolyte. Potential cycling of Pt PC in chloride ion contaminated electrolyte leads to specific adsorption at the active sites of the platinum. It leads to significant changes in the H UPD feature of Pt (100) and oxide layer formation in the voltammogram The peak intensity decreases with increase in concentration of chloride ions. Irreversible adsorption of chloride ion on the active site mask s and prevents the H ads/des and PtO formation Specifically adsorbed chloride ions were cleaned by applying the potent iodynamic technique that is by holding the contaminated electrode at 1.0 V (vs Ag/AgCl) in 0.1 M NaOH for 15 min. Surface cleanliness was confirmed from the intense H UPD peak and overlap ping straight line feature of the impedance spectra of the electrode before and after contamination and cleaning.

413

Effect of the Addition of Rare Earth on the Hydrogen Storage Properties of TiFe Alloy

Md Alam^{1*}, Pratibha Sharma¹, Jacques Huot²

¹Indian Institute of Technology Bombay, Powai, Mumbai, India

²Univ. du Québec à Trois-Rivières, Canada

*164170004@iitb.ac.in

TiFe alloy is one of the good candidates for solid-state hydrogen storage. Despite having fast kinetics and good capacity, its first hydrogenation, also called activation, is difficult. Numerous studies have been reported on enhancing activation kinetics of TiFe alloy by various means such as ball milling, high-pressure torsion, doping with transition elements, etc. However, very few studies have been reported on TiFe alloy added with rare earth elements. This project aims at providing detailed insight into the effect of the addition of rare earth on the hydrogen storage properties of TiFe alloy. Previous investigations on the effect of adding Zr to TiFe showed that the resulting alloy was multiphase with a zirconium-rich secondary phase that acts as a gateway for hydrogen to reach the main TiFe phase. In the present investigation, rare earth elements La and Ce, which form binary hydride at room temperature, were chosen as additives. Two different synthesis routes- arc melting and ball milling and a combination of both have been studied. It was found that the activation kinetics of TiFe alloy improved remarkably at room temperature with the addition of rare earth. It was also found that the thermodynamics of TiFe hydrogenation was unaffected by the rare earth addition. To understand the hydrogen sorption behavior- X-ray diffraction, and SEM along with EDX of as-synthesized and de-hydrogenated samples were performed. From these measurements, it was observed that the additive is forming a separate phase and in most cases as an intergranular phase. This hydride phase is probably acting as a gateway for hydrogen to reach the main TiFe phase.

414

Co₃O₄ Nanosheets on Zeolite-Templated Carbon as an Efficient Oxygen Electrocatalyst for a Zinc-Air Battery**Raj Kumar Bera***

Center for Nanomaterials and Chemical Reactions, Institute for Basic Science, KAIST, Daejeon,

34141, Republic of Korea.

*chemsraj@ibs.re.kr

Zinc-air batteries (ZnABs) are among the most promising energy storage devices, offering multiple advantages of high energy density, low manufacturing cost, high safety, and environmental benignity. However, challenges remain in the development of ZnAB electrode materials due to the lack of efficient air-electrode catalysts for solving the problems regarding slow kinetics of the oxygen reduction/evolution reactions (ORR/OER) and poor durability. Here, we demonstrate the formation of Co₃O₄ nanosheets with rich oxygen-vacancy defects grown on zeolite-templated carbon (ZTC) for electrocatalytic application in a ZnAB. Hydrophobic ZTC serves as a substrate for the growth of the Co₃O₄ nanosheets. Oxygen vacancies are generated by the borohydride reduction of Co²⁺, followed by oxidation with oxygen in atmospheric air. The resultant oxygen-vacancy defective Co₃O₄ nanosheets on ZTC (Co₃O₄ NS/ZTC) exhibits excellent bifunctional electrocatalytic activity towards the ORR/OER and high durability, compared with commercial Pt/C and RuO₂ catalysts. The high bifunctional electrocatalytic activity is attributed to the sheet-like structure and oxygen-vacancy defects of Co₃O₄ and the high surface area and uniform microporosity of ZTC. The ZnAB with the bifunctional electrocatalyst exhibits excellent discharge performance and long-term charge/discharge cycling stability.

415

Enhancing the activity of electrocatalyst by mesoporous over layers**Sibimol Luke,^{1,2,3} Aswani Yella,² Akshat Tanksale,³ Alexandr N Simonov⁴**¹ IITB-Monash Research Academy, IIT Bombay, Mumbai 400076, India² Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Powai, Mumbai 400076, India³ Department of Chemical Engineering, Monash University, Wellington Road, Clayton, Victoria 3800, Australia⁴ School of Chemistry, Monash University, Wellington Road, Clayton, Victoria 3800, Australia

The quest for finding highly electroactive and stable electrocatalyst for oxygen evolution reaction (OER) in acidic medium is active for several years. Nevertheless because of the strong anti-correlation between the activity and stability of catalysts at low pH, the efforts are not quite successful yet. Many of the highly stable reported catalysts are of less use in industry as these are limited by their suboptimal activity and less selectivity for OER. Mixed metal oxides, strain induction and doping are few different methods to enhance the activity. Another technique to increase the electrocatalytic activity is by thin a thin overlayer on the catalyst. It alters the surface charge density at the surface of the composite and also between the layers. This synergistic interaction contributes to improved electro catalytic activity either by increasing the active sites for water oxidation with weak binder energies. This work is a study on how mesoporous TiO₂ and Al₂O₃ overlayers plays a role in enhancing the activity of a non-noble metal oxide catalyst.

Industry Innovations in Energy

Technological Innovations and R&D Advances Related to Energy Systems in ONGC

Omkar Nath Gyani

Head-Institute of Reservoir Studies
ONGC, Ahmedabad



ONGC is a premier global energy company engaged in Exploration and Production (E&P) of crude oil and natural gas. It has a unique distinction of being a company with in-house service capabilities in all areas of Exploration and Production aimed at finding and accreting oil and gas reserves under an optimal field development plan. ONGC has been actively pursuing technological innovation projects and applied research programs in major areas of reservoir characterization (seismic interpretation and attribute analysis, rock and fluid characterization, geological modeling etc.), field development (reservoir simulation), well engineering (drilling and completions), production enhancement (stimulation, artificial lift optimization) and improving field recovery (Improved Oil Recovery IOR, Enhanced Oil Recovery EOR) for its onshore and offshore fields.

In recent years, ONGC is collaborating with reputed national and international institutes to undertake advanced Research and Development (R&D) projects for developing technologies to enhance exploration and maximize recovery.

Current Trends and Challenges in Engineering Global Renewable Projects

D. R. Shanthi

Senior General Manager, Group Sector Head-Renewables
Tata Consulting Engineers, Bangalore



- Introduction to TATA and TCE
- Types of projects handled-Solar/Wind/Battery energy storage systems (BESS)
- Design capabilities & Services offered
- Case studies to illustrate the unique challenges faced in projects handled-Solar/Wind/BESS/Hybrid projects, the solutions provided, and Value additions proposed

Sustainable Engineering Solutions for Energy and Environment

Dr. Prasanna Rao Dontula

CTO

A.T.E. Enterprises, Bangalore



Energy and environment are among the most important areas to be addressed at the national as well as at a global level. Apart from clean energy generation, addressing the demand side of the energy conundrum could be a more sustainable method to address the problem. Industrial, commercial, and residential sectors account for over 90% of the electrical consumption. These sectors primarily comprise buildings, and heating, ventilation, and air conditioning accounts for 40-48% of building energy needs. As on date, heating requirements account for 90% of the air-conditioning demand but going ahead, as India and other large tropical countries develop, the cooling needs are projected to grow significantly, and exceed heating needs by the time we reach the fourth quarter of the century.

Such unprecedented growth in electricity consumption is not sustainable, and needs the attention and contribution of all. The subject of HVAC has to be addressed to its core, which is people's health and productivity. Demand-side management and technology development are two thrust areas to tackle the issue from the consumption end. Thus, building design, building energy modeling, and low-energy HVAC solutions are need of the day. A.T.E., through its various sustainability-oriented businesses, is committed to contribute to solving this problem.

A.T.E. is a world leader in the development and deployment of indirect evaporative cooling solutions. It has also developed solar thermal concentrator technology that could be adopted for different industrial and commercial applications. Similar to energy, increasing water consumption with urbanisation and industrialisation is an area of equal concern for the planet. In the water sector, A.T.E. designs and deploys innovative effluent treatment solutions which include low-energy sludge drying and bio-gas generation.

Innovations, Experiences and Impact of Empereal-KGDS Renewable Energy Technologies

Dr. Suresh Kumar

Executive Vice-President and R&D Director
Empereal-KGDS Renewable Energy, Coimbatore



Renewable energy sources and technologies can possibly give answers for the long-standing vitality issues being looked by the creating nations. To meet the vitality required for such a quickly developing economy, India will require a guaranteed stockpile of 3-4 times more energy than the all out energy devoured today. In India, from the last two and half decades, there has been a lively quest for exercises identifying with look into, advancement, show, generation and use of an assortment of sustainable power source innovations for use in various parts. In this regard, Empereal-KGDS has been a proud associate in the nation's research and development in various renewable energy technologies. Empereal-KGDS has been performing in innovation and development in the field of concentrated solar thermal power (CSP), thermal desalination, thermal energy storage solution, relevant technical consultancy and feasibility study since 2008. We commissioned an indigenous 7020 m² Linear Fresnel Reflector (LFR) solar energy collector, conveying saturated steam for power generation at Gwalpahari, Haryana in October 2011, which was awarded by Indian Institute of Technology Bombay (IIT-B) based on a global tender. The Department of Science and Technology (DST) awarded Empereal-KGDS a prestigious project of national importance titled "Design, Fabrication, Testing, and Installation of Solar Multi-Effect Distillation System for providing potable water in arid rural areas". The direct steam generating Linear Fresnel Reflector (LFR) solar energy collector of 1404 m² is suitably integrated with a biomass boiler for round the clock operation. The plant is producing 6 m³/hour of desalinated water having Total Dissolved Solid (TDS) less than 5 Parts per Million (ppm).

As a third party independent technology consultant for Reliance Solar Power project at Dhursar, Rajasthan, we carried out technical consultancy services to upgrade the extant conduct for 125 MW LFR plant. We have developed, commissioned and successfully demonstrated an innovative LFR system CPC and ETC based receiver and ganged reflector tracking mechanism for Indian Institute of Technology (IIT-M) to hatch direct superheated steam at 45 bar and 400 degree Celsius under continuous operation. This work also embodied a high temperature thermal storage solution based on phase changing molten salt technology. We have been assigned as a technical consultant for detailed engineering and execution of LFR with PCM for the setup of indigenous 3.5 MWe for 24 hours by IITB, sponsored by National Thermal Power Corporation (NTPC). We also pulled off a detailed feasibility report for developing 50 MW solar thermal power plant combined with a desalination plant of at least, 15,000 m³/day capacity employing hybridization with biomass at Vallinokkam Salt Complex in Ramanathapuram with ILF consulting engineers for Tamil Nadu Industrial Development Corporation Ltd. (TIDCO). We were a part of designing and retrofitting an innovative 120 TPD flue gas based seawater desalination (FGSW –Desal) system at the Simhadri 4x500 MW coal power plant of NTPC. Being first of its kind, this FSGW-Desal minimizes the environmental footprint of the coal plant and encourages water reuse. We are also developing energy efficient Solar thermal energy based Forward Osmosis seawater desalination technology with the help of DST.

Cooling Tower Configuration Evaluation System

Ilayaraja Palani

Technical Services Head – Corporate Energy & Technical services
Aditya Birla Group, Mumbai



Cooling towers are an integral part of manufacturing sectors particularly power plant, refinery, Metals and petrochemicals. Underperformance of cooling tower leads to high fuel consumption & penalty. Performance depends on ambient conditions, water quality, heat load and water treatment program. Limited Battery limit level interaction of multiple agencies has often led to incorrect design and under performance. Low performance leads to increase in fuel cost by 2 to 3 % or decrease in production. There is need to have integrated approach to solve cooling tower related problems.

Methods/Statistical analysis: Integrated novel evaluation system has been devised to solve cooling tower problems. CTI (Cooling tower Institute) tool was used to evaluate performance of cooling tower. However, it was found to be limited to counter current cooling tower. Developed excel spread sheet for iterations and evaluation of cross flow cooling tower.

Graphical illustration of CT operation through Psychometric chart, cooling water network pinch, online weighing of fills, water quality and ambient condition information from CTI technical papers were integrated to provide criteria for evaluating operating cooling tower and selection of fill type & configuration for new cooling tower.

Developed tool was key in solving perennial cooling tower problems in Grasim Industries chlor alkali units, fiber units, power plants and Fertilizer. Same was used to select & evaluate cooling tower for expansion projects

Findings:

- Cooling tower performance is very sensitive to Liquid- Air Ratio. Water distribution mechanism needs a thorough check specially in large cooling towers.
- Severe Bio fouling can happen even when microbial growth is well within limit in circulating water
- Use of counter current CT equations for cross flow tower results in gross under sizing where cooling range exceeds 5 deg C.

Improvements/Applications: Applicable to all energy intensive sector & power plants. The methodology guides to select right cooling tower configuration and identifies root cause of existing cooling tower under performance.

Process Re-engineering for Sustainable Business

Dr. Gopal Sahu

Lead Scientist at R&D

Grasim Industries (Aditya Birla Group)



Strong competitive market or entering big player in market changes the product pricing and benefit of overall business. This challenges businesses to develop products for new applications and/or to reduce the OPEX for sustaining similar profit margin. On the other hand, stringent environmental regulations force businesses to invest heavily on treatment of effluents and pollutant gases. At the same time, there is a demand in international and national markets for sustainable (Green) products.

For mitigating these challenges Industries need to strategically invest on re-engineering their process to reduce their OPEX as well as to reduce effluent generation. There should be proper investment and selection of technology to get saleable products from effluent which can compensate on its treatment.

Reduction of Dead Pot Voltage in Aluminium Reduction Cell to Reduce Energy Consumption

Sanjeeb Kumar Behera

Associate GM-Electrical & Instruments
Vedanta Aluminum, Jharsuguda



Aluminium smelting is conducted chiefly through the Hall-Héroult electrolysis process. This process involves passing a direct current through a solution of alumina dissolved in molten cryolite; adding cryolite allows the electrolysis to occur at a lower temperature. The electrolyte is placed in an iron vat, which serves as the cathode, lined with graphite. In addition to this carbon anodes are immersed in the electrolyte. Upon passage of electrical current through the electrolyte, the molten aluminium metal is deposited at the bottom of the cathode while carbon is oxidized to form carbon dioxide at the anode. Soderberg technology uses a continuous anode which is delivered to the cell in the form of a paste and which bakes in the cell itself.

A pot is a vessel in which Aluminium reduction happens by electrolysis process. A current of 340ka is passed and a reaction between alumina and carbon reduces to Aluminium. Presently in Vedanta, Jharsuguda aluminum location we have around 1XX stopped pot across 3 pot line which consumes a total power 3XX_MWh/day. An innovative project was undertaken with an objective to reduce the stopped pot voltage. This objective was achieved by the use of bypassed shunt methodology where some amount of current was bypassed from the stopped pot compensating bus bar to the main bus bar of next live pot.

Predictive Analytics using Advanced Pattern Recognition tool for Fleetwide Assets Monitoring and Diagnostics

Parshuram Mishra

Group Head-Operation System Management
TATA Power, Mumbai



Equipment monitoring systems are already in use to detect and trend anomalies in process parameters, but the challenge remains to know at an early stage when bad stuff is beginning to happen. The early warning signs that a piece of equipment is starting to fail are often subtle and can go unnoticed even to the most trained operator.

Fleet-wide monitoring concept involving the predictive analytic software has gained a lot of significance due to the potential benefits of advance warning of impending failures, economics of centralized monitoring compared to individual locations, comparative monitoring of similar units and equipment across the fleet, knowledge capture from the experience etc. Process (Plant data), Technology (Predictive Analytic Software) and People (Subject Matter Expert) are the key elements of the Fleet wide monitoring program and has put into place the 'Right Information' to 'Right People' at 'Right Time' and enables information sharing between various stakeholders before an optimal decision is taken. The software uses Advanced Pattern Recognition (APR) Technique to predict desirable values of each parameter modelled and detects anomalies that are outside the normal expected pattern. The presentation discusses the fleet wide monitoring concept, usefulness and focus mainly on data-driven empirical models for various assets of the power plant. It further elaborates how the predictive analytic software identifies the impending equipment failures in advance (days, weeks, or sometimes months) before they happen for the entire range of equipment covered under the fleet.

Intelligence Implemented in Transmission System” – The Tata Power Perspective

Amok Agarwala

Head – Automation & Communication
TATA Power, Mumbai



Rising energy demand has brought in a tremendous growth in the power sector over the past few decades resulting in wide spread complex Grids. Real time monitoring coupled with Remote Management of assets is a key requirement. This requires a two-way communication system and handling a huge quantum of data from/to the field level in real time. Rapid development in the electronic technology with high reliability of systems, increased communication bandwidths, better system performances would make introducing digital technology a reliable and a cost-effective solution for achieving the above.

In TATA Power, the first Supervisory Remote Control System was installed in the year 1972 for control of Mahalaxmi Sub-Station from Parel over a pilot wire cable. The system was primitive by today's standards; telephone relays were used for logic with rudimentary control functions. Over a period, various automation technology has been implemented for its Transmission and Distribution network i.e. all receiving stations, distribution substation and 50% of the consumer substations are automated and centrally monitored and controlled from the Power System Control Centre. Today, Power System Network information is available on click of mouse anytime, anywhere in Tata Power. The journey towards automation started way back in 1980s, with the introduction of high-speed digital communication systems.

Agile communication network with decentralised substation automation and centralised control centre architecture is what ensures TATA Power to keep up its commitment of reliable and stable power to the consumers. The technology's infusion with a philosophy of unified operations has reshaped the automation schema and brought excellence outnumbering the earlier performance of our Transmission & Distribution wires. TATA Power formulated vital inclusions in automating its substation with centralised control centre. This information intelligence blended power system operations paved way for new inception of technologies to meet the growing consumers, regulatory needs and grid disciplines. This presentation covers some of the technologies adopted by Tata Power to become the consumer's first choice to deliver the reliable and safe green power to their door steps, which is our commitment. These technologies include Unified SCADA System, Distribution Management System, SDH Communication Network, IEC61850 based Sub-Station Automation System, Centralised Fault Monitoring and Analysis, Voltage Control from Remote, Cyber Security Management, Analytics, Lab-Setup for Product Evaluation, MPLS-TP Communication, DTS and OTS using fibre optic for real-time monitoring of HV Cables etc.

Adaptive Control of HVAC Equipment for Energy Saving and Demand Adjustment

Dr. Arvind M. T.

Co-founder & Managing Director
Amplebit Energy, Bangalore



HVAC systems contribute to 40-70% of the energy consumption in commercial and industrial setups. Moreover, HVAC design capacity is typically much more than normal requirement, in order to address worst case scenarios and growth requirements. Consequently, the systems are operated inefficiently and lead to significant energy wastage. We describe a frame work for incorporating basic intelligence into HVAC systems so that they can adapt to dynamic requirements in a decentralized fashion, in order to reduce energy wastage. Further addition of prediction capabilities enable the equipment to adjust to target load profiles, subject to operational constraints.

Compressed Air Energy Storage System

Shashikant Maurya

Manager-Gas Turbine Operations
Siemens-Gas & Power, Gurgaon



Electrical Energy Storage (EES) refers to a process, in which electrical energy is converted into different forms of energy suitable for storage and then be converted back into electrical energy on demand. The renewable energy domain based on solar energy conversion systems or wind are clean and cost-effective alternatives, but their inherent diurnal, seasonal or intermittent availability compromises their usefulness in matching peak demand and being scaled up to provide base load. An efficient energy storage could transform intermittent, renewable energy sources into a stable commodity with the capacity to be dispatched according to load and market price.

CAES operates in by storing energy in the form of high pressure compressed air during the periods of low electric demand and then releasing the stored compressed air energy to generate electricity to meet high demand. The CAES plant regenerates the power, the compressed air is released from the cavern and heated through a recuperator before being mixed with fuel and expanded through a turbine to generate electricity. Since there is no compressor needed for such a turbine, the turbine can generate over twice as much electricity compared to simple cycle configuration.

Siemens Energy has been leading in developing product and solutions for CAES plant which are efficient, lower emissions, near flat heat rate, high turndown, rapid regulation response and up to turnkey offering. The expander train uses products that are derivatives of industry proven turbines (SST-800 & SGT-800), with high ramp rate and faster start capability.

Fuel Cells: Next Generation Power Generators

Ganapathy Iyer

Manager, Research & Technology

Thermax, Pune



Many technologies are competing to be the next IC engines. The leaders in the pack are of-course Fuel Cells and Batteries. Thermax has identified Fuel Cells as the first mover and is actively developing Fuel Cell based solutions for Strategic as well as Commercial applications. The journey of fuel cell development has many challenges in indigenization of the technology and integration with the end-use. The talk will describe these challenges and their present solutions.

Cost Efficient Functional Coating Technology for Eco-Friendly Concentrated Solar Thermal (CST) and PV applications

Srinivasa Rao Atchuta

Project Scientist

ARCI-Centre for Solar Energy Materials, Hyderabad



Industrial sector requires both electrical and thermal energy for their manufacturing processes. Recently, Indian industries are exploiting various renewable energies sources especially solar energy. Solar Photovoltaic (PV) and Solar Thermal (Concentrating Solar Power (CSP) / Concentrating Solar Thermal (CST)) can support both power generation and industrial process heat applications. Remarkably, solar PV technology has been reached a mature level cost by continuous efforts from the past few decades after publicized national solar mission programme. Whereas, concentrating solar power (CSP) is too low compared to PV due to some critical challenges. The challenges for CSP are related to the lack of reliability of direct normal irradiance (DNI) data-base and lack of indigenous CSP components such as mirrors, receiver tubes etc. But there is a high potential for widespread adoption of CST technology in India, especially for industrial process heat applications typically operated in the range of 90 to 250°C.

Apart from CSP/CST technology, another major issue related to PV Technology in India is the “Soiling of PV panels”. The panels are mounted on rooftops/fields to maximize their exposure to sunlight. Unfortunately, this type of outdoor placement leads to continuous exposure of the solar panels to high soiling rates, drastic weather and moisture. Total energy output of an uncleaned solar panel in high dust area can drop by 30-40%. Additionally, Reflection losses and fogging of materials is unfavourable for various applications like solar, optical and automobile. Reflection losses in PV cover glass reduce the over efficiency of the module.

In view of the above, the technology presentation will focus on the importance of cost-effective development of functional materials and coatings from laboratory to industrial scale, their prototype development and performance in the real field conditions and challenges in technology transfer to the industry.

करोड़ों मुस्कान बनाए हमें ऊर्जावान

करोड़ों जिंदगियों को रौशन करना और ऊर्जावान बनाना ही हमारा मूलमंत्र है। जहाँ एक ओर हम देश को ऊर्जा प्रदान करते हैं, वहीं हमारे सामाजिक कल्याण के कार्यक्रम लोगों को सशक्त बनाते हैं। आखिरकार, इन लोगों की मुस्कान ही हमारी प्रेरणा है।

ओएनजीसी सी एस आर

जिन्दगी को
छूने का प्रयास

www.ongcindia.com

शिक्षा ■ स्वास्थ्य देखरेख ■ आजीविका सृजन ■ दिव्यांग हेतु पहलें ■ पर्यावरण और धरोहर संरक्षण ■ खेल संवर्धन

प्रकृति के अस्तित्व में ही हमारा अस्तित्व है

Reclaimed 957 Hectares of land with plantation of 2.17 million saplings during 2018-19. Till March 31, 2019 a total of around 98.18 million trees have been planted covering an area of 39,336 Hectares



कोल इण्डिया लिमिटेड

विश्व की वृहत्तम कोयला उत्पादक संस्था
A Maharatna Company

पर्यावरण की सुरक्षा का संकल्प



TCI Chemicals (India) Pvt. Ltd.

Moving Your Chemistry Forward

**OVER 95% READY STOCK AVAILABLE AT
TCI DISTRIBUTION CENTER
CHENNAI & HYDERABAD**

**New Competitive Pricing | High Purity Available
Fastest Delivery Across India**

TCI PRODUCT CATEGORIES

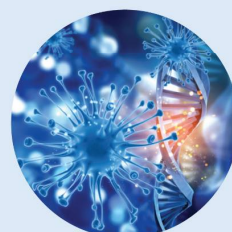
CHEMISTRY

- Grignard Reagents & Alkyl Metals
- Metal Catalysts for Organic Synthesis
- Ligands
- Asymmetric Organometallic Catalysts
- Reagents for Suzuki-Miyaura Cross-Coupling Reaction
- Chiral Building Blocks
- Fluorinating Reagents, Building Blocks & Fluorinated Bioactive Compounds
- Reagents for Multicomponent Reaction (MCR)
- Reagents for Click Chemistry
- Reagents for C-H Bond Activation Reaction
- Reagents for Fluorous Chemistry
- Reagents for Functional Group Transformation & Introducing Reaction



LIFE SCIENCE

- Nucleosides, Nucleotides & Nucleic Acids
- Amino Acids
- Sugars
- Lipids
- Terpenes
- Steroids
- Phenylpropanoids & Aromatic Polyketides
- Alkaloids
- Antibodies
- Bioconjugation
- Antioxidants
- Epigenetics
- Inhibitors
- Pharmaceutical Ingredients



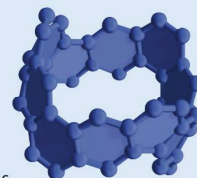
ANALYTICAL CHEMISTRY

- GC Derivatizing Reagents
- HPLC Labeling Reagents
- Ion-Pair Reagents for HPLC
- Solvents for HPLC & Spectrophotometry
- HPLC Columns
- Reagents for NMR Spectrometry
- Reagents for Mass Spectrometry



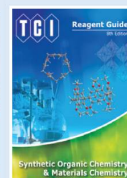
MATERIALS SCIENCE

- Functional Organic Dyes
- Nanocarbon Materials
- Organic Nonlinear Optical Materials
- Organic Semiconducting Materials
- Organic-Inorganic Hybrid Materials
- Polymer Research Reagents
- Solar Cell Reagents



CHEMICALS BY CLASS

- Carbocyclic Compounds
- Heterocyclic Compounds
- Metal Compounds
- Boron Compounds
- Silicon Compounds
- Phosphorous Compounds
- Quaternary Ammonium Salts



29,000+ Research Chemicals | 9,000+ Unique Products | 1,000+ New Products Annually

B-28, Phase II, 5th Cross Street, MEPZ-SEZ, Tambaram, Chennai - 600 045, Tamilnadu, India.

Toll Free: 1800 425 7889, TEL: +91-44 2262 0909, FAX: +91-44 2262 8902, E-mail: sales-in@tcichemicals.com

www.TCIchemicals.com/en/in/

Cost Efficient Functional Coating Technologies for Eco-Friendly Concentrated Solar Thermal and PV application



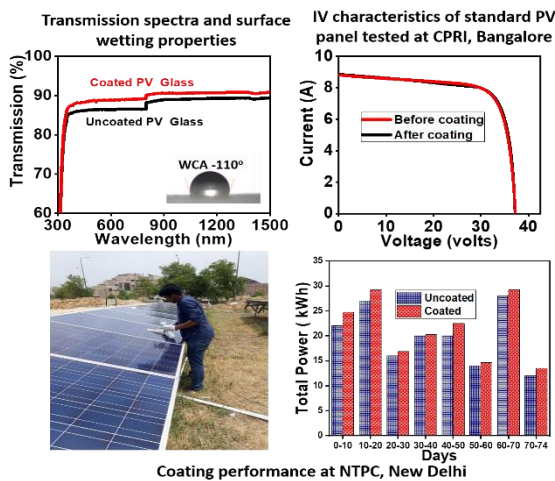
Ambient temperature curable easy to clean coating with high transmittance and high weather stability

Technology Overview

Easy to clean technology is generally related to protect the solar devices from dust/dirt, corrosion and all sorts of weather conditions. PV devices are subjected to substantially high soiling rates, constant weather and moisture exposure. A general challenge is finding one protective coating that has best-in-class qualities of easy to clean property, high weather and mechanical stabilities, no loss in power conversion efficiency after deposition on PV panels and curable by ambient conditions. ARCI's new technology will provide solution for the above-mentioned issues.

Key features

- Low cost production
- No loss in transmittance & hydrophobic property: > 110° water contact angle
- High weather stability & High mechanical stability



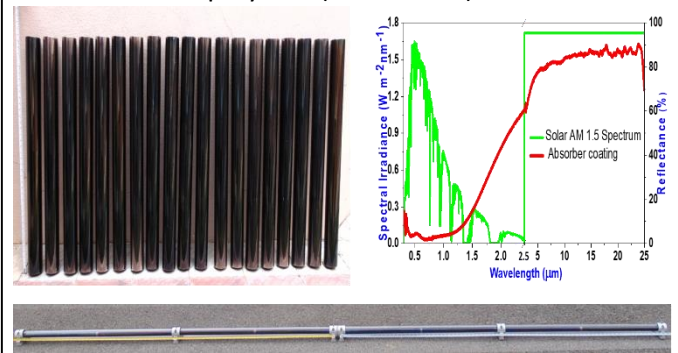
Cost-efficient Solar Receiver Tube Technology for Low and Medium Temperature Solar Thermal Applications

Technology Overview

Indian industrial sector needs both power and thermal energy for their manufacturing processes. Recently, Indian industries shown interest in exploit renewable energies, especially solar energy due to their economic and environmental-friendly advantages. In this regard, ARCI has developed a cost-effective selective coating to convert solar radiation into a heat which can be used for low and medium temperature industrial process heat applications. The technology attracting many industries and has been transferred to an Indian industry as non-exclusive basis (Greenera Energy India Pvt. Ltd).

Key features

- High selective properties (Solar Absorptance ~95%; Spectral emittance ~0.12)
- Low heat loss property: ~0.14 at 250 °C & Temperature stability: < 250 °C
- High corrosion resistance > 200 hrs withstand in salt spray test (ASTM B117)



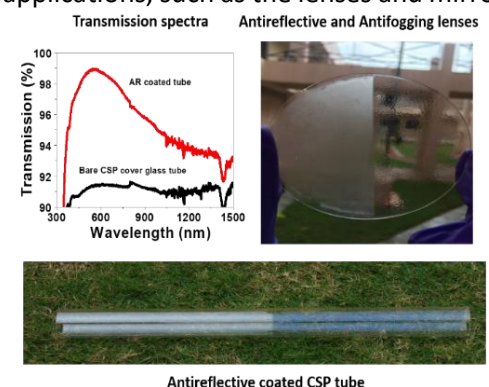
Dual Functional (Anti-Reflective & Anti-Fogging) Coatings for Solar, Optical & Other Applications

Technology Overview

Dual Functional (Anti-Reflective & Anti-Fogging) Coatings are important for transparent materials. Anti-fogging coatings and are now often used on transparent glass or plastic surfaces used in optical applications, such as the lenses and mirrors found in glasses, goggles, camera lenses, and binoculars.

Key features

- High transmittance (>96 %)
- Low temperature curable (<100 °C)
- Highly Weather stable (withstands humidity > 90 %)
- High mechanical stability
- Highly Super-hydrophilic (Contact Angle < 5°)





National Centre for Photovoltaic Research and Education (NCPRE)

Supported by Ministry of New and Renewable Energy, Government of India

Indian Institute of Technology Bombay, Mumbai, India

www.ncpre.iitb.ac.in



Introduction

- Setup in October 2010 by MNRE, Govt. of India as a part of Jawaharlal Nehru National Solar Mission (JNNSM)
- NCPRE mandate is to provide the strong PV research, education and Manpower training to achieve the JNNSM targets
- Funded with INR 475 million during Phase - I (2010 -2016) and INR 623.5 million for Phase - II (2016 -2021)
- Involvement of 28 faculty members from 8 departments at IIT Bombay and over 200 students and staff
- Working as a facilitator towards the Education & Training, Research and Technology Development in thrust areas of c-Si solar cells, Thin film materials & devices, Energy storage, Power electronics & Solar module reliability
- Launched Industry Affiliate Programme (IAP) to support the mutual needs of industry and academia in PV research

Research Activities

❖ C-Si Solar Cells

- Develop industrial process for high efficiency 6" x 6" mono c-Si using Cu front metal contact and concepts like PERC, IBC and carrier selective contact

❖ Thin Film Materials & Devices

- Develop Tandem solar cell technology for Perovskites, Si or CZTS materials
- Develop new absorber layers compatible with perovskite absorbers

❖ Energy Storage

- Develop and demonstration of 10 Ah Li-ion battery in commercial scale
- Develop and demonstration of Na-ion battery and Redox flow battery technology

❖ Power Electronics

- A test bench for all power interface in Solar PV system under grid condition
- Develop Industry standard product for stand-alone PV system, Grid connected inverter, PV powered induction motor pump & Hybrid power management

❖ Module Reliability

- Field assessment of installed PV systems in different climatic zones of India
- Develop new models suitable for accelerated testing pertinent to Indian climate
- Module material quality assessment & New characterization tool development



Education & Training

- Author books/monographs in solar PV and related areas
- A new course on PV Technology
- Target to train 300 B.Tech, M.Tech. & PhD students
- Training entrepreneurs and handholding of startups in PV

Facilities Developed

- ✓ Diffusion Furnace, Evaporator & Plasma etching tool
- ✓ FTIR, ALD and PECVD
- ✓ Adhesion tester and UV-Vis-NIR
- ✓ Belt furnace and screen printer for solar cell metallization
- ✓ Dopant Profiler & High resolution LBIC
- ✓ Battery fabrication Glove box and testing tool
- ✓ Battery cell (cylindrical & pouch) fabrication facility Line for 4 kWh scale prototyping
- ✓ Battery Cyclers with 20A, 40V applications
- ✓ FESEM, EVOSEM, 3D microscope
- ✓ Solar cell I-V, QE, Suns-Voc measurement system, Dynamic Mechanical Loading System
- ✓ Module simulator, Environmental chamber, IR camera, EL setup, Portable I-V tester, PV Module laminator
- ✓ InGaAs camera for EL/PL imaging of solar cells/modules



We are thankful to

Title Sponsor



Gold Sponsor



Coal India Limited

A Maharatna Company
www.coalindia.in

Sponsors



सत्यमेव जयते



Science and Engineering Research Board (SERB)
Department of Science and Technology (DST)
Govt. of India



TCI Chemicals (India) Pvt. Ltd.
Moving Your Chemistry Forward



Energy Swaraj Foundation
Energy by Locals for Locals