

**INTERNATIONAL WORKSHOP ON**  
**TRENDS IN SOLAR POWER GENERATION AND ENERGY HARVESTING**  
**DUBAI**  
**27-29 MARCH 2017**  
**BRIEF REPORT**

The global demand for energy is currently growing beyond the limits of installable generation capacity. To efficiently meet the future energy demands, energy security and reliability should be improved and alternative energy sources should be aggressively investigated. An effective energy solution should be able to address long-term issues by utilising alternative and renewable energy sources. Of the many available renewable sources of energy, solar energy is clearly a promising option as it is abundantly available at most places and is also the cleanest energy resource on earth. Solar power, especially as it reaches more competitive levels with other energy sources in terms of cost, may serve to sustain the lives of millions of underprivileged people in developing countries.

The recent trends are to decrease the cost of the energy generation either by introducing the low cost processing techniques or to increase the efficiency of the solar cells. After 1<sup>st</sup> and 2<sup>nd</sup> generation of bulk silicon based solar cells and thin-film Si/CdTe/CIGS based solar cells, respectively, the 3<sup>rd</sup> generation technologies are underway. Many new technologies include photo-electrochemical cells, polymer solar cells, quantum dot, tandem / multi-junction solar cells, up-conversion and down-conversion, surface plasmonic, nano-crystal solar cells and other novel innovations and inventions. The aim is to define an approach for Solar Power Generation and intersecting themes for enabling better informed policy-making.

In order to deliberate on the current trends in solar power generation, its storage, harnessing and related issues, the Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) jointly with the Amity University, UP, India - Dubai Campus organised an International Workshop on ***‘Trends in Solar Power Generation and Energy Harvesting’*** in **Dubai** during **27-29 March 2017**. The chief organisers of this international scientific event were Prof. Dr. V. K. Jain as the Chairman and Dr. Abhishek Verma as the Secretary from the Amity University, UP, India; Dr. Chithirai Pon Selvan as Secretary from the Amity University, Dubai Campus; and Prof. Dr. Arun P. Kulshreshtha and Mr. M. Bandyopadhyay from the NAM S&T Centre.

The Inaugural Session commenced with a welcome note by Dr. Narayanan Ramachandran, Pro Vice Chancellor, Amity University, Dubai followed by the remarks by Dr. V.K. Jain, Distinguished Scientist & Professor, Amity Institute of Advanced Research and Studies (Materials & Devices), Amity Institute of Renewable and Alternative Energy, Amity University, Noida, India who spoke on current developments in solar energy research world over, underscored the background of the workshop and explained the technical programmes planned for the same. Mr. M. Bandyopadhyay, Senior Expert, NAM S&T Centre in his remarks

presented the genesis of the event touching upon the basic issues related to solar power generation and energy harvesting and also gave a presentation with a brief description of the activities of the NAM S&T Centre. This was followed by the remarks by Mr. David Provenzani, Managing Director, Architaly Green Energy DMCC, Dubai who spoke on the initiatives taken to provide solar energy to schools and universities in Dubai. In his Presidential Address, Dr. Ashok K. Chauhan, Founder President of the Amity Group of Institutions stated that Solar power either through directly converting sunlight into electricity by using Photovoltaics (PV) or by indirect use of concentrated solar energy has a competitive edge over other sources in terms of cost and may serve to sustain the lives of millions of underprivileged people in developing countries and said that the Amity University has already started several programmes in these areas. Dr. Atul Chauhan, Chancellor, Amity University briefly expressed his views about the role being played by the Amity University in the promotion of education and training in the fields of renewable energy. At the end of the Inaugural Session, a book on compilation of abstracts of papers and CVs of the participants who would make their presentation during the workshop was launched. The Workshop was attended by **13** renowned scientists as invited speakers and **33** senior experts and professionals from **23** countries, including Afghanistan, Cambodia, Cuba, Egypt, Gambia, India, Indonesia, Iran, Iraq, Malaysia, Mauritius, Morocco, Nepal, Nigeria, Palestine, Sri Lanka, South Africa, Tanzania, Togo, Turkey, United Kingdom, Zambia and Zimbabwe. Further, **39** scientists from the host country UAE participated in the Workshop including 11 experts who had made their presentations. Moreover, several representatives of the government agencies, NGOs, academia and industry from UAE attended the Inaugural Session. Besides this, there was a poster session in which **24** Poster Presentations were made.

The overall programme of the Workshop was conducted in nine Technical Sessions and the Concluding Session.

The invited speakers were - **Dr. Vikram Kumar** [Emeritus Professor, Centre for Applied research in Electronics (CARE) & Coordinator, Nanoscale Research facility, Indian Institute of Technology, Delhi, India] , **Dr. V. K. Jain** [Formerly: Director Grade Scientist, Solid State Physics Lab. (DRDO) Distinguished Scientist & Professor, Amity Institute of Advanced Research and Studies (Materials & Devices), Amity Institute of Renewable and Alternative Energy, Amity University, Noida, India ], **Dr. Chetan Singh Solanki** [Professor, Department of Energy Science and Engineering, Indian Institute of Technology Bombay (IITB), India], **Dr. R. K. Kotnala**, [Chief Scientist & Head, Materials Physics & Engineering Division, National Physical Laboratory, India], **Prof. P. K. Bhatnagar** [UGC BSR faculty fellow, Department of Electronic Science, Delhi University South Campus, New Delhi, India], **Prof. Mridula Gupta** [Professor, Department of Electronic Science, University of Delhi, South Campus, New Delhi, India], **Dr. A. Subramanyam** [Professor, Department of Physics, Indian Institute of Technology Madras, Chennai, India], **Prof. Viresh Dutta** [Head, Centre for Energy Studies, Indian Institute of Technology, New Delhi, India], **Prof. R. Bhattacharya** [Visiting Faculty, Centre of Excellence of Green Energy & Sensor Systems (CEGESS), Indian Institute of Engineering Science and Technology (IEST), Shibpur-Howrah & Delhi Technological Institute, New Delhi, India], **Dr. R. M. Mehra** [Professor Emeritus, Department of Electronics and Communication Engineering, School of Engineering and Technology, Sharda University, Knowledge Park 3, Greater Noida, UP, India], **Dr. Hiranmay Saha** [Chair Professor and co-ordinator, The Centre of Excellence for Green Energy and Sensor Systems, Indian Institute of Engineering Science and

Technology, Shibpur, West Bengal, India], **Prof. Trystan Watson** [Associate Professor, A230 Engineering East, Swansea University Bay Campus, Fabian Way Swansea SA18QQ, UK] and **Prof. Dave Worsley** [Research Director, Baglan Bay Innovation Centre, Central Avenue, Baglan Energy Park, Baglan SA12 7AX, UK].

The foreign participants (NAM Countries) were from - **Afghanistan** [Mr. Sultan Ali Javid, Advisor to the Minister Development and Energy, Ministry of Refugees & Repatriation, Waysalabad, Kabul], **Cambodia** [Mr. Row Vattanak, Deputy Chief of Generation Planning Office, Electricité Du Cambodge, St. Preah Yukunthor, Khan Daun Penh, Phnom Penh City], **Cuba** [Prof. José Luis Pérez González, Specialist for the Control of the Activity of S&T, Directorate of Science, Technology and Innovation, Ministry of Science, Technology and Environment (CITMA), Havana], **Egypt** [Dr. Essam Tawfik Mohamed Elshenawy, Researcher, National Research Center, Solar Energy Department, Dokki, Giza], **Gambia** [Mr. Lamin Morikebba Jarju, Cadet Energy Officer, Ministry of Petroleum and Energy, Futurelec Buliding, Kotu, Gambia], **Indonesia** [Dr. Arya Rezavidi, Principal Engineer, B2TKE BPPT (Center for the Energy Conversion Technology, Agency for the Assessment and Application of Technology), Gedung, Puspitek Serpong, Tangerang, Selatan], **Iran** [Dr. Gholamreza Farahani, Scientific board, Manager of Telecommunication, Iranian Research Organization for Science and Technology (IROST), Ahmadabad Mostoufi Rd], **Iraq** [Dr. Falah Ibrahim Mustafa Al-Attar, Director, Solar Energy Research Center, Renewable Energy Directorate, Ministry Science and Technology, Baghdad], **Malaysia** [Mr. Mohd Fauzi Ismail, Director, Industrial Centre of Innovation in Energy Management, SIRIM Industrial Research, No. 1 Persiaran Dato' Menteri Section 2, Shah Alam], **Mauritius** [Mr. Vishwamitra Oree, Senior Lecturer, Electrical and Electronic Engineering Department, Faculty of Engineering, University of Mauritius], **Morocco** [Prof. Ismail Mekkaoui Alaoui, Professor of Physics, Cadi Ayyad University, Physics Department, Faculty of Sciences Semlalia, BP 2390 Marrakech 40000], **Nepal** [Prof. Dr. Jiba Raj Pokharel, Vice-Chancellor, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur], **Nigeria** [Engr. Muhammed Musa Gaji, Principal Scientific Officer, Energy Commission of Nigeria, Department of Renewable Energy, Abuja], **Palestine** [Eng. Makawi Diab Hraiz, Director, Industrial Synergy Center, Palestine Polytechnic University Hebron], **Sri Lanka** [Dr. D. S. M. De Silva, Senior Lecturer, Department of Chemistry, Dalugama, University of Kelaniya], **South Africa** [Ms. Sophie Tshimangadzo Mulaudzi, Lecturer, Department of Physics, University of Venda (UNIVEN), Thohoyandou], **Tanzania** [Mr. Ahmed Mmingwa, Principal Engineer, Tanzania Electric Supply Co. Ltd, Dar Es Salaam], **Togo** [Dr. Komi Apélété AMOU, Assistant Professor, BLV Gnassingbe Eyadema, Université De Lome, LOME], **Turkey** [Assoc. Prof. Dr. Alp Osman, Head Senior Researcher, TÜBİTAK Marmara Research Center, Barış Mah., Dr. Zeki Acar Cad, Kocaeli], **Zambia** [Mr. Nchimunya Mwiinga, Lecturer II, Department of Physics, School of Natural Sciences, University of Zambia, Lusaka], **Zimbabwe** [Mr. Everson Bhunu, Science and Technology Officer, Ministry of Higher and Tertiary Education, Science and Technology Development, Causeway, Harare].

The Indian participants / speakers were - **Mr. Vineet Saini**, [Scientist-D, Solar Energy Research Initiative Program, Technology Mission Division, Department of Science and Technology (DST), Govt. of India, Technology Bhavan, New Delhi], **Dr. Kulvinder Singh** [Associate Professor, Faculty of Science, University of Delhi], **Dr. Abhishek Kardam** [Assistant Professor, Amity Institute of Advanced Research Studies, Amity Institute of Renewable & Alternative

Energy, Amity University, Noida], **Dr. Alok Kumar Rai** [Associate Professor, Amity University, Noida], **Dr. Subramanyam Ganumukkala** [Director, Siri Exergy & Carbon Advisory Services (P) Ltd, Hyderabad], **Dr. Subhra Das** [Professor and Head, Department of Renewable Energy, Amity School of Applied Sciences (ASAS), Amity Education Valley, Manesar, Gurgaon, Haryana], **Dr. Abhishek Verma** [Assistant Professor, AIARS(M&D), Amity University UP, Noida], **Prof. Kanchan Saxena** [Head, AIRAE, Amity University UP, Noida], **Dr. Javid Ali** [Assistant Professor, Department of Physics, Jamia Millia Islamia, New Delhi], **Mr. Harsimran Singh Bindra** [Scholar, AINT, Amity University UP, Noida], **Ms. Astha Jain** [Mplus Company, Delhi], **Mr. Sidhant Jain** [Amity University UP, Noida], **Mr. Bidyut Barman** [AIARS(M&D), Amity University UP, Noida], **Mr. Vivek Kumar** [AIARS(M&D), Amity University UP, Noida], **Mr. T Munetsiwa** [Amity University Haryana], **Dr. Rakhi Grover** [Assistant Professor, Amity University, U.P.], **Dr. O.P. Sinha** [Associate Professor, Amity Institute of Nano-Technology Amity University, Noida], **Dr. Ayana Bhaduri** [Department of Applied Physics, Amity University, Gurgaon], **Dr. Sanjeev Sharma** [Associate Professor, Mechanical Engineering Department, Amity University Haryana] and **Ms. Meenu Galyan** [Research Associate, NAM S&T Centre, New Delhi].

The participants / speakers from UAE were - **Mr. David Provenzani** [Managing Director, Architaly Green Energy DMCC, Dubai], **Ms. Preetha Sreekumar** [Faculty Member, Department of Electronics Engineering, Higher Colleges of Technology, Abu Dhabi], **Mr. Ashok Thangavelu** [Head – Sales & Marketing (MENA), Echosolar, Dubai], **Mr. Stefan Muckstein** [Chief Operating Officer, Enerwhere DMCC, Dubai], **Mr. Claudio Palmieri** [CEO, Green Emirates - CLS Energy Consultants DMCC, Dubai], **Dr. Shashank Khurana** [Assistant Professor, Department of Mechanical Engineering, Birla Institute of Technology & Science, Pilani, Dubai], **Mr. Abraham Samuel** [Assistant Professor, Amity University Dubai], **Dr. Rajiv Selvam** [Assistant Professor, Manipal University, Dubai], **Dr. Swaroop. R** [Assistant Professor, Amity University Dubai], **Mr. Ganesan Subramanian** [Assistant Professor, Manipal University, Dubai] and **Mr. Anoo Babu** [BIPV Solar Expert GOPA – International Energy Consultants GmbH, Dubai].

The twenty four poster presentations were made by the students of the Amity University, Dubai [Mr. Bilal, Ms. Fathima Al Zahra, Ms. Asma Sharif, Mr. Mohammed Mansoor, Ms. Mrunal Sanjeev Zuting, Ms. Nibhrita Tiwari, Mr. Affan, Mr. Udelle, Mr. Akash Bandyopadhyay, Mr. Yousif Khatir, Ms. Jeswinnie, Mr. Mamnur Rashid, Mr. Nelvin Chummar Vincent, Mr. Jalees Saqib Kamal Azhari, Mr. Akashdeep, Mr. Kaleem Ahmed and Mr. Shrey Gary]; Amity University, UP, India [Mr. Harsimran Singh Bindra, Ms. Astha Jain, Mr. Sidhant Jain, Mr. Bidyut Barman, and Mr. Vivek Kumar]; Amity University, Haryana, India [Mr. T Munetsiwa]; and Jamia Milia Islamia, India [Dr. Javid Ali].

The NAM S&T Centre was represented by Mr. M. Bandyopadhyay, Senior Expert and Ms. Meenu Galyan, Research Associate.

The Invited Speakers presented their papers on ‘Photovoltaic Research – an Indian Perspective’ by **Dr. Vikram Kumar**; ‘Recent Trends in Solar Energy Generation and Harvesting’ by **Dr. V. K. Jain**; ‘Towards Giving Right to Clean Light’ by **Dr. Chetan Singh Solanki**; ‘Hydroelectric Cell Invention : A Boon for Green Energy & Environment’ by **Dr. R. K. Kotnala**; ‘Organic

Solar Cells - Recent Developments – a Brief Review’ by **Prof. P. K. Bhatnagar**, ‘Recent Trends in Energy Saving Environmental Friendly OLEDs’ by **Prof. Mridula Gupta**; ‘Recent trends and challenges in the third and fourth generation Thin film Photovoltaics’ by **Dr. A. Subramanyam**; ‘Photovoltaic based DC Microgrids and AC Microgrids using Hydrogen Storage System’ by **Prof. Viresh Dutta**; ‘Self-cleaning of Solar panels’ by **Dr. R. Bhattacharya**; ‘Stable, highly efficient and low cost Perovskite Solar Cells’ by **Prof. R. M. Mehra**; and ‘Evolution of Silicon solar Cells : Past History and Present Trend’ by **Dr. Hiranmay Saha** ; ‘Third generation solar cells from laboratory to factory; developing a scale-up route for perovskite solar cells to turn buildings into power stations’ by **Prof. Trystan Watson** and ‘Active Buildings; the use of solar active facades for generation storage and release of energy’ by **Prof. Dave Worsley**.

The presentations made by the participants from the NAM countries were on ‘The Status of Solar Power Generation in Afghanistan’ by **Mr. Sultan Ali Javid**; Solar Photovoltaic Energy in Cambodia “An Opportunity with Obstacles” by **Mr. Row Vattanak**; ‘Cuban's Trends in Solar Power Generation and Energy Harvesting’ by **Prof. José Luis Pérez González**; ‘Effect of Partial Shading on the PV Module Output’ by **Dr. Essam Tawfik Mohamed Elshenawy**; ‘Policies, Programmes and Current Status on Solar Power Generation in the Gambia’ by **Mr. Lamin Morikebba Jarju**; ‘Evaluation of Operation of Independent Power Producer (IPP) 5 MWP Photovoltaic Power Generator in Kupang, East Nusa Tenggara, Indonesia’ by **Dr. Arya Rezavidi**; ‘Effects of Partial Shading on MPPT of PV System’ by **Dr. Gholamreza Farahani**; ‘The Future of Solar Energy Investment in Iraq’ by **Dr. Falah Ibrahim Mustafa Al-Attar**; ‘A Review on Solar Thermal Technologies for Low and Medium Temperature Industrial Process Heat’ by **Mr. Mohd Fauzi Ismail**; ‘Solar Energy Harvesting in Mauritius: Opportunities and Challenges’ by **Mr. Vishwamitra Oree**; ‘On Morocco’s Renewable Energy after COP 22’ by **Prof. Ismail Mekkaoui Alaoui**; ‘Chemical Storage of Solar Energy through the Use of Slaked Lime’ by **Prof. Dr. Jiba Raj Pokharel**; ‘Sustainable Renewable Energy Possibility for Nigeria as the Way Forward’ by **Engr. Muhammed Musa Gaji**; ‘Evaluating the performance of the PV-Modules available in Palestinian market’ by **Eng. Makawi Diab Hraiz**; ‘Fabrication of CdS/CdTe Thin Film Solar Cells via the Technique of Electrodeposition’ by **Dr. D. S. M. De Silva**; ‘An overview of solar energy landscape, solar radiation and solar cells studies in Limpopo province of South Africa’ by **Ms. Sophie Tshimangadzo Mulaudzi**; ‘The Solar Resource’ by **Mr. Ahmed Mmingwa**; ‘Simulation and Prediction of the Power Output for Photovoltaic Systems’ by **Dr. Komi Apélé AMOU**; ‘Quantitative Analysis Of Commercial Photovoltaic Solar Cells And Modules With Electroluminescence’ by **Assoc. Prof. Dr. Alp Osman**; ‘Sigmoid Characteristics of Static Resistance – Voltage Curves for Diodes and Solar Cells under Dark Conditions: Theory, Simulation & Experiment’ by **Mr. Nchimunya Mwiinga**; ‘Trends in Solar Power Generation and Energy Harvesting in Zimbabwe’ by **Mr. Everson Bhunu**.

The participants from India and UAE presented their papers on ‘Advance Research in Photovoltaic Thermal System: A Review’ by **Mr. Vineet Saini**, ‘X-Ray Switching In Commercial Grade Solar Panel’ by **Dr. Kulvinder Singh**, ‘Rapid Thermal charging properties of Nanomaterials embedded PCM composites for Solar thermal energy storage applications’ by **Dr. Abhishek Kardam**, ‘High Rate Capability and Long Cycle Stability of Mixed Transition Metal Oxides as an Anode Material for High-Performance Lithium Ion Batteries’ by **Dr. Alok Kumar Rai**, ‘Energy Audit of 5 MW Solar power Plant – A case study’ by **Dr. Subramanyam Ganumukkala**, ‘Overview of Risk Assessment in Solar PV Power Plant’ by **Prof. Subhra Das**,

‘Dye Sensitized Solar Cells: Role of Dyes and Electrolytes’ by **Dr. Rakhi Grover**, ‘Organic-Inorganic Quantum Dots Hybrid Nanostructures for Solar Energy Harvesting’ by **Dr. O. P. Sinha**, ‘Review on Inorganic Organic Hybrid Solar Cell “or” Review on Nanocrystalline Silicon Germanium for Solar Cell Material’ by **Dr. Ayana Bhaduri**, ‘Aerodynamic Design & Development of Solar Car’ by **Dr. Sanjeev Sharma**, ‘Dubai Solar Schools Initiative, A Project to Provide Solar Energy to Schools & Universities in Dubai’ by **Mr. David Provenzani**, ‘Review of Control Strategies used in Interfacing Solar Power Generation Units to the Grid’ by **Ms. Preetha Sreekumar** ‘Net Metered Solar Rooftop Schemes - An overview’ by **Mr. Ashok Thangavelu**, ‘Solar Power for Temporary Off-Grid Use’ by **Mr. Stefan Muckstein**, ‘The Importance of Provision of Construction Financing in Solar Industry’ by **Mr. Claudio Palmieri**, ‘Design and Performance Study of a Solar Operated Aqua Ammonia Absorption Refrigeration System’ by Mr. Joseph Jeyasurya and Ms. Gayathri Hariharan (co-author: **Dr. Shashank Khurana**), ‘Architectural insights on passive strategies towards optimum Solar Designs’ by **Mr. Abraham Samuel**, ‘Design and Fabrication of Solar Powered Automotive Air Condition’s Refrigeration System’ by Mr. Nakhwa Umair and Ms. Neethu Vijayan (co-author: **Dr. Rajiv Selvam**), ‘Comparison of PV Technologies and Forecasting PV Power Generation using Artificial Neural Networks’ by **Dr. Swaroop R**, ‘Internet of Things (IOT) Based Solar Panel Monitoring System for Higher Efficiency’ by **Mr. Ganesan Subramanian**, ‘Utility-Scale Solar PV and Demand Side Based Integrated Solar PV’ by **Mr. Anoo Babu**, and ‘Current status of Solar Power in India’ by **Ms. Meenu Galyan**.

The Concluding Session was presided over by Dr. Narayanan Ramachandran, Pro Vice Chancellor, Amity University, Dubai and Dr. V.K. Jain, Amity University, NOIDA, India. Mr. M. Bandyopadhyay, NAM S&T Centre initiated the discussion on a draft Dubai Resolution on ‘Trends in Solar Power Generation and Energy Harvesting’ and invited comments/inputs from the participants which were then incorporated in the draft after deliberations. The finalised Resolution was then read out before the house and unanimously adopted during the session.

Three Best Poster Awards for the poster presentations after having been judged by a 3-member committee were given to Mr. Vivek Kumar, Amity University Noida [First Prize]; Mr. T. Munetsiwa, Amity University Haryana [Second Prize]; and Ms. Fathima Al Zahra, Amity University, Dubai [Third Prize]. The Certificates of Participation were handed over to the participants by Dr. Ramachandran and Dr. V.K. Jain.

Besides the above, an interaction meeting with the foreign delegates (NAM Countries) was held which was presided over by Dr. Ashok Chauhan, Founder President, Amity Education Group. Dr. Chauhan also had a separate meeting with the senior Indian scientists in order to explore the possibilities of networking among the solar scientists in the developing countries and the Amity University.

The participants thanked the organisers and hosts, Amity University, for the excellent arrangements made and efficiently coordinating and conducting the Workshop.

A Dhow Cruise Dinner at Dubai Marina was hosted by the organisers on 28<sup>th</sup> March (second day) for the invited guests and participants.