

**World's Largest Solar Thermal Project Commissioned**

A solar thermal project commissioned at the Ivanpah plant generates 392 MW of electricity, thus significantly displacing 13.5 million tons of carbon dioxide emissions over its 30 year life cycle:

- The project is owned by NRG Energy Inc., Google Inc. and Bright Source Energy and is located close to Las Vegas, near the California-Nevada border
- About 3,00,000 computer controlled heliostats are installed to concentrate solar energy onto three 459 feet tall towers for generating super heated steam that drives the turbines



Three Power Towers in the Ivanpah Plant

- The cost of installation is about \$5,500 per kilowatt which is more than a coal-based plant, but less compared to a nuclear power plant.

**Trade issues between India and US on the Jawaharlal Nehru National Solar Mission (JNNSM)**

A clause on Domestic Content Requirement (DCR) in solar energy based installations under JNNSM has sparked a row of controversy between India and US. It mandates the use of indigenously manufactured module/cell for solar developers in India instead of imported modules:

- US trade representatives filed a complaint in February 2013 and again in February 2014 with the World Trade Organisation (WTO) citing that the DCR clause discriminates against US manufacturers

- On the contrary, the Indian commerce minister said that the JNNSM policies are strictly WTO compliant and only intend to create a solid indigenous manufacturing base
- As per the WTO rules, the dispute settlement begins with consultations between the two parties involved for a maximum period of 60 days, failing which a panel would be constituted.

**Soft Costs have Maximum Contribution in Solar Installation Costs**

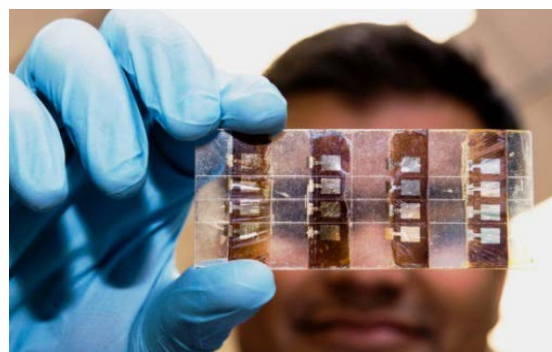
The National Renewable Energy Laboratory (NREL) has reported that finance and non-hardware costs account for about 64 % of the total installation cost in residential solar projects, which is significantly higher than other cost components:

- A survey was conducted by interviewing Photovoltaic (PV) installers
- The highest component of the soft costs were supply chain costs (\$0.61/watt) followed by installation labour (\$0.55/watt)
- Third party ownership added \$0.78/watt for residential systems and \$0.67/watt for commercial projects.

**New Solar Cell Material Emits Light at Night**

Scientists from Nanyang Technological University (NTU) have developed a new solar cell from perovskite that not only produces electricity from light but also emits light:

- Light emitting property is uncommon for solar cells and could be used for making lasers



New Solar Cell Material developed from perovskite



- Scientists claim that the new material is five times cheaper than the silicon solar cells
- It could be used on facades of offices or shopping malls for display or used for decorations.

### Indian Renewables Budget is Reduced

For the financial year 2014-15, the Ministry of New and Renewable Energy (MNRE) has been allocated a budget of INR 441 crore (US\$72 million):

- The budget is lower compared to the previous financial year
- In 2013-14, MNRE ended up disbursing only INR 426 crore (US\$ 69 million) out of INR 1,500 crore (US\$ 246 million). The budget cut will affect the state rooftop solar policies the hardest since developers will now find it increasingly difficult to access the 30% capital subsidy.

### Latest CERC Guidelines for Solar PV Projects

The Central Electricity Regulatory Commission (CERC) has proposed a generic levelized generation tariff for solar PV for FY 2014-15 as Rs. 6.99/kWh (without Accelerated Depreciation) and Rs. 6.33/ kWh (with Accelerated Depreciation):

- The tariff order considers project cost of Rs. 6.12 crores/ MW
- The project cost predominantly comprises cost of equipment, land and power evacuation
- This capital cost has seen a steep decrease of almost 25% compared to the capital cost from the previous year.

### Solar REC trading goes up but future prospects still remain uncertain

The end of financial year (FY) 2013-14 witnessed frantic trading of solar and non-solar RECs in the market. Volumes of supply bids as well as demand bids rose dramatically compared to previous months. However, this was not due to the enforcement of RPOs, but because of March being the last month of FY14:

- 11,019 solar RECs were cleared at a base price of Rs. 9300 per certificate and the total

number of unsold solar RECs at the end of 2013-14 was 139,489

- 658,727 non-solar RECs were cleared at the base price of Rs. 1500 per certificate and the total number of unsold non-solar RECs at the end of 2013-14 was 5,368,253
- Unless RPOs are enforced in a stringent manner, developers using the REC market mechanism will continue to take higher risks in terms of returns on investments.

### SunEdison LLC backs out of Indian Solar PV Project

Missouri based SunEdison LLC dropped plans of developing a 20 MW solar project in India:

- The decision was based on concerns that local PV cell manufacturers would not be able to ramp up the supply within the stipulated time
- The project was won under the DCR category where use of local products was mandated
- Some other issues raised included increase in price of cells by local manufacturers making such projects unviable

### Indo U.S. Energy Dialogue

Dr. Kamanio Chattopadhyay, Dr. Pradip Dutta and Dr. Dave S. Ginley from SERIIUS participated in the India-US Clean Energy Joint Energy Dialogue in New Delhi from March 5-11, 2014. They presented the recent research updates to the U.S. Secretary of Energy, Ernest Moniz and Deputy Chairman, Planning Commission, Montek Singh Ahluwalia. SERIIUS also participated in several of the working groups, and in other events such as meeting the U.S. Agency for International Development (USAID). The dialogue helped in building a partnership with the Joint Clean Energy Research and Development Center (JCERDC), Centre for Building Energy Research and Development (CBERD) Consortium etc.

### SERIIUS Symposium at IISC

A SERIIUS meeting was held at the Indian Institute of Science (IISc) in Bangalore, India on March 31<sup>st</sup>, 2014. It began with a discussion focused on research highlights, collaborations, milestones, and planning for the future. This was followed by a symposium at the same venue on "Research Directions in Solar Energy-2014", from April 1 -3, 2014 as part of SERIIUS outreach activity.



## 2013 MAGEEP Scholars' Summary

Solar Energy Research Institute for India and the United States (SERIIUS) Visiting Fellows and Scholars Program was initiated by SERIIUS and the McDonnell Academy Global Energy & Environmental Partnership (MAGEEP) with funding from SunEdison LLC. The program aims at providing researchers from both the countries an opportunity to interact and exchange knowledge. This in turn would help in building skilled expertise in SERIIUS priority areas such as PV, Concentrated Solar Power (CSP) and Solar Energy Integration (SEI). A brief description about the visiting scholars and their research work is described below:

### 1) PV-3 Nanostructured Absorbers and Electrodes

- a) **Title of Work:** Energy Storage in Titanium Di-oxide (TiO<sub>2</sub>) Nanostructures



**Alok Mani Triparthi (IIT-B)** carried out research on energy storage in lithium-ion battery. His work includes the design of lithium-ion battery electrode in a single step. Highly oriented, single crystal dendritic TiO<sub>2</sub> nano-

columns were fabricated using a single step Aerosol Chemical Vapor Deposition (ACVD) on stainless steel current collectors for use as high-rate lithium-ion battery anodes. It was found to be compatible for battery application without use of any conducting carbon and binder.

**IIT-B Mentor:** Prof. Sagar Mitra  
**WuSTL Mentor:** Prof. Pratim Biswas

- b) **Title of Work:** Perovskite Solar Cells Based On TiO<sub>2</sub> Obtained Using Aerosol Chemical Vapor Deposition (ACVD)



**Aakanksha Chaudhary (IISc)** got an opportunity to work with Dr Pratim Biswas's group (Aerosol and Air Quality Research Laboratory) at Washington

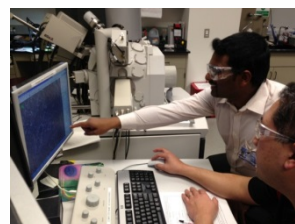
University in St. Louis. As part of the Fellowship, her work involved synthesizing different morphologies of nanostructured titania using ACVD. This nanostructured titania is integrated

in a perovskite heterojunction solar cell. Some of the early devices demonstrate an efficiency of about 5 %. This work aims towards meeting one of the milestones identified by PV-3 project in SERIIUS.

**IISc-B Mentor:** Prof. Srinivasan Raghavan  
**WuSTL Mentor:** Prof. Pratim Biswas

### 2) PV-6 Novel Materials for Intrinsic Stability in Harsh Environments

**Title of Work:** Influence of Soiling Layer on Quantum Efficiency and Spectral Reflectance on Crystalline Silicon PV modules



**Jim Joseph John (IIT-B)** studied a challenge in large-scale deployment of PV systems, soiling on PV modules,

which is known to reduce the performance of the PV module. The SERIIUS project PV-6 Task 3 'Dust and Soiling Mitigation' aims at quantifying the losses in the PV modules and developing economically viable dust mitigation solutions. Teams from IIT Bombay (India), ASU (USA) and NREL (USA) have attempted at understanding the chemical composition of the soil layer, the effect of tilt angle on soiling rate and quantifying the effect of soiling on quantum efficiency, spectral reflectance and incident angle.

**IIT-B Mentor:** Prof. Anil Kottantharayil,  
**ASU Mentor:** Prof. G. "Mani" TamizhMani

### 3) PV-2 Organic Photovoltaic Materials and Devices

**Title of Work:** The Study of Lead Perovskite Devices: Contacts and Processing



**Sudip Saha (IACS)** worked with Dr. Dana Olson and Dr. Joey Luther from NREL on perovskite material based

solar cells devices. The main goal of the work was to replace Spiro-OMeTAD with an organic polymer. To do so they chose a simple structure: ITO/PEDOT:PSS/Perovskite/PCBM/Al. They found a technique to convert PbI<sub>2</sub> into methyl

ammonium lead iodide to perform better. They could achieve an initial maximum efficiency of 3.16% with enhanced  $V_{oc}$  of 1.36V.

**IACS Mentor:** Prof. Amlan Pal

**NREL Mentors:** Dr. Dana Olson and Dr. Joey Luther

**4) CSP-2 Low Cost Heliostat for Brayton Cycle**

**Title of Work:** Techno-Economic Optimization of Heliostat Layout for 1MWe Power Plant, for India



**Asmita Marathe (Thermax)** visited NREL for developing a

model for optimization of the heliostat size considering a 1MWe solar field and the constraints imposed by tropical weather in India and the distributed mode of power generation. The comprehensive model can be used for determining the optimum heliostat sizes as well as field orientation vis-à-vis the cost. Software such as SolarPILOT, Soltrace and SAM are used for the research. The location for the study is Chitradurga, Karnataka.

**Thermax Mentor:** Dr. R.R. Sonde

**NREL Mentor:** Tim Wendelin

***Consortium Leads***

Indian Institute of Science, India & National Renewable Energy Laboratory, USA

***Research Thrust Leadership***

Indian Institute of Technology Bombay, Center for the Study of Science, Technology and Policy, Sandia National Laboratories, RAND Corporation

***Consortium Partners***

***Institutes and National Laboratories***

International Advanced Research Centre for Powder Metallurgy and New Materials, National Institute of Solar Energy, Lawrence Berkeley National Laboratory

***University Partners***

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