News Updates

Inauguration of International Solar Alliance (ISA) at NISE, India

Prime Minister Shri Narendra Modi addressing the International Solar Alliance meeting held at NISE on 25th January 2016
Photo Courtesy: http://www.intsolaralliance.org.

The Prime Minister of India, Shri Narendra Modi, and the President of France, Mr. François Hollande, on 30th November 2015, together established a first of its kind international and inter-governmental organization called the International Solar Alliance (ISA) with its headquarters in India. ISA is a coalition of solar-rich countries located between the Tropics of Cancer and Capricorn. Its overarching objective is to promote and accelerate the development and deployment of solar energy technologies in these countries to ensure an energy-secure and sustainable future. Members of the ISA will use mutually agreeable approaches to bridge the current gaps and will assist each other in increasing solar energy utilization. Currently, there are 121 members including USA, China, and Brazil. The interim secretariat of the ISA is currently seated at Surya Bhawan in the National Institute of Solar Energy (NISE), Gwalpahari, Gurgaon. In this maiden meeting of ISA, the Government of India (GoI), promised 5 acres of land in the NISE campus to establish the ISA headquarters. The government has also contributed INR 175 crore for ISA's corpus fund. In addition, the GoI is also offering training programs to bolster the knowledge of member countries of the ISA. These training programs will support projects such as solar home lighting, solar pumps, etc. An Interim Administrative Cell (IAC) will be working toward the transition of the ISA from a de facto to a de jure entity. The establishment of ISA in the campus of NISE is expected to provide great synergistic alliance, in the future, through mutual learning and augmenting businesses in the India.

Currently, institutes such as the Renewable Energy Policy Network for the 21st Century (REN21), International Renewable Energy Agency (IRENA), International Energy Agency (IEA), and the Renewable Energy and Energy Efficiency Partnership (REEEP) are working toward similar goals. The ISA will, therefore, not attempt to replicate the efforts of these organizations. Instead, it will network with these international bodies and supplement their efforts in realizing solar energy targets.

ISA's Mission and Vision: "To provide a platform for cooperation among solar resource rich countries where global communities, including bilateral and multilateral organizations, corporates, industries, and stakeholders can make a positive contribution to the common goals, of increasing utilization of solar energy, in meeting energy needs of ISA member countries in a safe, convenient, affordable, equitable and sustainable manner".

The Prime Minister of India, Shri Narendra Modi, with the President of France, Mr. Francois Hollande, at the launch of the International Solar Alliance held at NISE on 25th January 2016

SERIIUS Select Project Highlights

1) Thrust area - PV: Flexible Glass Substrates

Team Members: Corning, NREL, and IIT-B

A key goal of the overall sustainable Photovoltaics (PVs) thrust is to enable solution-based atmospheric processing that is compatible with low-cost roll-to-roll manufacturing methods. The development of robust substrates capable of high-throughput processing enables this goal. One of the PV projects under SERIIUS is

focused on supplying flexible glass substrates and technical support to enable the evaluation of disruptive PV material systems, device designs, and high-throughput fabrication methods. The flexible glass substrates are ≤200µm thick and optimized for device substrate and hermetic barrier applications. The substrates are compatible with both sheet-based and roll-to-roll processes such as conveyance, vacuum deposition, solution coating, lamination, patterning, and printing.

Corning® Willow® Glass flexible substrate – discrete sheet.
Photo Courtesy - Corning

The project focuses on integrating flexible glass substrates across PV research activities of the SERIIUS program. Specifically, the flexible glass substrates are potentially enabling for PV technologies such as Copper Indium Gallium Selenide (CIGS), Copper Zinc Tin Sulfide (CZTS), Organic Photovoltaics (OPVs), and perovskite devices manufactured in roll-to-roll processes. In addition to the use of flexible glass as a device substrate, evaluation of its use to address Potential-Induced Degradation (PID) of PV modules has begun. The beneficial properties of the flexible glass include its thermal capability, surface quality, optical performance, mechanical flexibility, chemical compatibility, and barrier properties. The flexible glass is being produced on spools that are 1.3m wide and 300m long. These can be cut to shape or slit to meet collaborator and device process requirements.

Going forward, the key focus areas for this activity include collaborations on device performance, process scaling, and device reliability. While process scaling includes increased focus on roll-to-roll device fabrication, device reliability includes evaluation of the flexible glass, as a hermetic barrier, for device encapsulation. In addition, the flexible glass will also be supplied for evaluation as a Concentrated Solar Power (CSP) mirror substrate. These SERIIUS topics specifically benefit from Corning's experience in flexible glass roll-to-roll processing, carrier-based processing, hermetic frit sealing, and mechanical reliability.

Corning® Willow® Glass flexible substrate – glass spool for roll-to-roll processing.
Photo Courtesy - Corning

2) Thrust area- Solar Energy Integration: Feasibility Analyses of Polysilicon Manufacturing in India

Team Members: CSTEP, NREL, IIT-B, MNRE, and industry partners

This study examines the scope of polysilicon manufacturing in India and the policy framework required to promote such manufacturing. There are three main processes to manufacture Polysilicon - Siemens, Fluidised Bed Reactor (FBR), and Upgraded Metallurgical Grade (UMG). As of now, Siemens process accounts for 90% of the global polysilicon manufacturing. Based on expert opinion, the optimal size of a Siemens-type plant is currently 24,000 TPA, which can produce about 5 GW of c-Si PV modules. For smaller manufacturing facilities, the capital cost per unit of output will be higher.

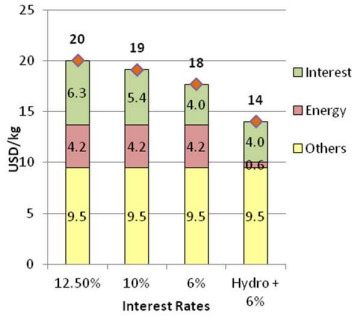
In our analysis, we assume that India establishes a 24,000 TPA polysilicon manufacturing facility, which will produce polysilicon at USD 20/kg. Interest and depreciation account for about 50% of the cost, while energy accounts for 20% of the cost. The Indian manufacturing cost (USD 20/kg) is higher than the corresponding cost in the United States (USD 18/kg), and this difference is in the cost of interest and energy. Therefore, we have performed scenario analysis to illustrate the

impact of energy costs and interest rates on the production of polysilicon in India.

1. Energy Costs: We have used two more scenarios apart from grid electricity at INR 5.5/kWh, namely, a dedicated coal power plant, which provides electricity at INR 3.5/kWh, and government-subsidized electricity equivalent to the cost of a dedicated hydropower plant (INR 0.75/kWh); Considering these scenarios, the polysilicon production cost decreases from USD 20/kg (grid power) to USD 18/kg (dedicated coal power plant) and USD 16/kg (subsidized hydropower).

2. Interest Rates: Cost decreases from a base case of USD 20/kg to USD 19/kg and USD 18/kg at interest rates of 12.5 % (base case), and 10%, and 6%, respectively.

3. A combination of a low interest rate (6%) and cheaper electricity (INR 0.75/kWh) can make the polysilicon production cost in India competitive with the current global spot price of USD 13/kg (as on January 2016).



Effect of Interest Rates and Energy Costs on Polysilicon Manufacturing Costs in India. Photo Courtesy: Polysilicon Manufacturing in India: Go or No-Go

Policy Recommendation: The Government should facilitate low-cost financing to promote such facility in the country and provide a dedicated power plant facility to supply reliable and low-tariff power similar to China.

WTO's Panel body rules against India in solar module dispute, Livemint (Feb' 2016)

The United States filed a case against India at the World Trade Organization (WTO) in 2013 for mandating Domestic Content Requirement (DCR) in solar PV projects. According to norms, products (that are being discriminated against and products being procured) should be similar or have a competitive relationship in the market.

- Recently, WTO ruled against India with a statement saying DCR is against internationals norms
- India plans to appeal against this decision at The Appellate body, WTO
- India and the United States continue to settle the dispute through mutual negotiations.

Big boost for rooftop solar in India, PIB (Dec' 2015)

The Cabinet Committee on Economic Affairs approved a massive increase in budget for rooftop solar power projects.

- Budget was increased from INR 600 crore to INR 5,000 crore for implementation of rooftop projects over the next five years (2019–2020)
- Installation of about 4,200 MW of rooftop solar capacity is expected across various sectors.

Centre approves INR 5050 crores as VGF for solar power projects, PIB (Jan' 2016)

The Cabinet Committee on Economic Affairs has approved INR 5,050 crores as Viability Gap Funding (VGF) for grid-connected solar power projects. This would help in creating 5,000 MW of additional capacity.

- This scheme will be implemented by the SECI under the guidelines of the Ministry of New and Renewable Energy (MNRE)
- Part of this 5,000 MW is reserved for solar projects using domestic or indigenously manufactured equipment.

GST poses risk to increase the cost of solar power, Bridge to India (Mar' 2016)

MNRE has come up with a report showing the implications of Goods and Services Tax (GST) on the renewable energy sector.

- The study concludes that the advent of GST will increase the cost of solar power by 14–16% because tax exemptions of various forms that are currently applicable on solar panels and many other components of solar PV systems will be removed once GST is implemented.

First hybrid power plant tender is released by SECI, ET (Mar' 2016)

The SECI has floated a tender for a hybrid solar power plant in Andhra Pradesh. According to the SECI, it is a first of its kind tender, which includes a solar power plant and a storage system.

- The total planned capacity of the plant will be 750 MW
- To accommodate the fluctuations in power generation, in this solar plant, a storage system of up to 100 MW will be mandatory

Sites for Solar parks in India are finalised, ET (Feb' 2016)

The MNRE has finalized the plan for setting up solar parks, which are clusters of solar plants, to meet the solar energy targets set by the GoI.

- MNRE has formulated a total of 34 solar parks across 21 states. This is an increase in the number of approved parks by six, compared with 2014–2015 plans
- Major states, according to potential capacity, are Andhra Pradesh (4 GW), Rajasthan (3.25 GW), and Madhya Pradesh (2.75 GW).

Government is working on new policy for solar equipment manufacturing, ET (Mar' 2016)

The government is working on a policy to bring changes in the production of solar equipment such as those used in making silicon wafers. An inter-ministerial committee, headed by the Secretary of Department of Industrial Policy and Promotion has proposed the following key points:

- Proposal for fiscal and non-fiscal incentives to drive a mega solar power project.
- Policy for domestic production of solar equipment.

Government to increase the installed solar power capacity target to 48 GW by 2019, ET (Apr' 2016)

The MNRE has revised its latest solar energy target to 48GW by 2019.

- 12 GW is expected to be installed by the end of fiscal year 2016-17
- 15 GW and 16 GW are to be installed by the end of fiscal years 2017-18 and 2018-19 respectively.

DRDO develops technology which supplies heat during night, The Tribune (Jun' 2016)

DRDO has developed a technology which can store solar heat and release it during the night.

- Phase-change materials are used to store thermal energy
- Thermal traps are provided above the roof to collect solar heat
- This technology can maintain a temperature between 7-10°C when the ambient temperature is around minus 30°C, with the exception of peak winter months (January and February).

Ten 'Solar Zones' to be sanctioned by India, PV-Tech (Jul' 2016)

In order to encourage deployment of solar PV projects and meet the 2022 solar targets, SECI has plans to sanction 10 'Solar Zones'.

- In the solar zones the government will only assist in purchase of land, but will not acquire it, unlike the process usually followed in solar parks
- Numerous points would be provided for the developer to establish grid interconnection without having to extend transmission lines beyond 25 kilometres
- Each zone will have a minimum of 10,000 hectares of land and will comprise of privately or government owned wasteland and uncultivated land
- SECI in collaboration with respective state governments will develop these zones.

SERIIUS Project Reviews

Review meetings were held at Hindustan Petroleum Corporation Limited (HPCL) R&D center on 3rd and 4th of February 2016 and at Indian Institute of Science (IISc.) Bangalore on 1st and 2nd of September 2016. The meetings were attended by SERIIUS thrust members and the Department of Science and Technology (DST) nominated Project Monitoring Committee (PMC). The PMC members reviewed the progress made thus far and provided valuable suggestions. The mid-term review of the project was held on 4th of April 2016.

IEEE 43rd Photovoltaic Specialists Conference (PVSC) (2016)

At the 43rd IEEE PVSC in Portland, OR, June 5-10, 2016, SERIIUS research had significant exposure through talks and posters. SERIIUS had 33 presentations (talks and posters) and India had the fourth largest country representation at the meeting. One of our posters, presented by Rajeev Dubey from IIT-Bombay, received a "best poster award" (His research represents joint work by IIT-Bombay and India's National Institute for Solar Energy). In addition to the presentations, SERIIUS had a booth in the exhibit area staffed by volunteers from our consortium who provided information about SERIIUS in general and SERIIUS presentations at the meeting.

SERIIUS - MAGEEP Intern Scholarship Highlights

Vinila Viswanathan (IISc)
IISc Mentor: Praveen Ramamurthy
NREL Mentor: Wade Braunecker

***Synthesis of Fluorinated Moieties for OPV Application*:** This work will focus on the synthesis of new material with high-charge transporting property and ambient stability obtained by fluorinated donors and acceptor moieties for organic PV application. This work will further lead to engineering of organic semiconducting materials resulting in higher efficiency PV devices.

Birinchi Bora (NISE)
NISE Mentor: Dr. O.S. SastryASU Mentor: Mani Tamizhmani

Non-Destructive and Destructive Characterization of Solar PV Modules: The focus of this work is on Cell-Module-Quantum Efficiency (C-M-QE) before and after accelerated reliability tests and Non-Destructive and Destructive Characterization of Polymeric Materials in PV Modules.

Shashwata Chattopadhyay (IIT-B)
IIT-B Mentor: Chetan Singh Solanki
ASU Mentor: Mani Tamizhmani

***Reliability of PV Modules, Micro-Inverters and Micro-Converters*:** In this project, the reliability of PV modules were investigated through a statistical analysis of field data using the Failure Mode, Effect and Criticality Analysis (FMECA) technique. The reliability of micro-inverters and micro-converters attached to PV modules will be determined by performing electrical characterization of post-stressed samples subjected to various accelerated stress tests.

Rajeev Dubey (IIT-B)
IIT-B Mentor: Anil Kottantharayil
NREL Mentor: Sarah Kurtz

***Reliability of PV Modules*:** This project aims at the development of accelerated test models for PV modules operating in hot climates and their field validation. These accelerated tests will provide climate-specific durability of the modules, thereby aiding in better quality assurance for PV modules, eventually increasing their lifetimes.

Eshan Dhar (IISc)
IISc Mentor: Pramod Kumar
SNL Mentor: Matthew Carlson

***Modeling of sCO2 Behavior Near Critical Point for Control Algorithms for Stable Cycle Operation*:** This project will involve modelling of sCO2 behaviour near the critical point for control algorithms and an analysis of loop dynamics due to variable heat input on account of isolation

variability for concentrated solar power application.

Pardeep Garg (IISc)
IISc Mentor: Punit Singh
MIT Mentor: Matt Orosz

***Modeling of Hybrid Concentrated PV and ORC-Based Thermal Systems*:** This project will involve exploring the design space for hybrid solar technologies (PV + scroll expander-based ORCs) and providing a deeper insight into the thermo-economic optimization of micro-grids involving ORCs with storage. Under this, a new scheme of power generation is proposed and optimized that couples concentrated PVs (CPVs) to solar thermal to charge a dual hot/cold thermal energy storage system promising reliable and cost-effective power supply.

Arun Narasimhan (USF)
USF Mentor: Yogi Goswami
IISc Mentor: Punit Singh

Modeling of a High-Volume-Ratio (> 3) Scroll Expander for Use in Distributed Small-Scale Power Generation (Less than 10 kW Test Scale): One of the objectives of this project is to design and commission a 10 kWe ORC test rig with a modified scroll expander using an electrical heater for the heat source. The test rig will then be used to evaluate the performance of the ORC system and the modified scroll expander.

Sara Turner (RAND)
RAND Advisor: Aimee Curtright
CSTEP Mentor: Thirumalai NC

Adapting the NREL System Advisor Model for the Indian Context: The purpose of this project is to adapt the National Renewable Energy Laboratory's System Advisor Model, for the Indian context. The model will be used to analyse opportunities for policymakers to accelerate the integration of solar technologies into the Indian energy system.

Interview

Mr. Gyanesh Chaudhary ,
Managing Director and CEO,
Vikram Solar

Interviewed by Dr. Mridula D Bharadwaj, Principal Research Scientist, CSTEP. The interview was conducted in July 2016 as part of Indo US Government Solar program (SERIIUS) under PACE-R/JCERDC.

***Q:** Which state or states in India have favorable policy framework to support domestic manufacturing of PV modules? Could you highlight the key incentives? Is Vikram Solar looking for expansion of manufacturing bases across India?*

A: Andhra Pradesh, Rajasthan, and Maharashtra definitely stand out, if we are to compare state-wise initiatives to support domestic manufacturing of solar modules. Mirroring the central government's vision of gaining self-reliance in solar by strengthening in-house capacity, these policies introduce incentives to aid the manufacturers in shouldering globally competitive ventures.

Key incentives of these policies are

- Easy allotment and long-term lease facility for land in solar parks
- Capacity generation-based incentives
- Government assistance in identifying and acquiring land suitable for solar plants
- Easy and fast single-window clearance within a month
- Ensuring bank finance at attractive rate.

These incentives can definitely help local manufacturers to circumvent issues while shouldering large-scale project development. Further nationwide assessment reveals that the national solar growth will not be significant without Indian states quickly adopting such a supporting policy framework.

***Q:** The trend in cell and module manufacturing capacity addition has been very progressive in*

recent years; however, the capacity utilization is not more than ~30-40%. Currently, in absence of policy support under NSM for domestic content in PV targets, what is the motivation for Indian *manufacturers to increase their capacities?*

A: The obvious obstacles, such as delays in acquiring land for infrastructural establishments, long gestation period of developing factories, and lack of effective policy framework implementation, present hurdles in the path to solar growth. However, as a domestic manufacturer, we trusted our in-depth market research, which showed incredible demand ratio with rising awareness, new government initiatives, and the global acceptance towards solar energy.

The recent increase in demand for solar adoption in industrial, institutional, and residential sector has also motivated manufacturers to plan expansion. New policies promising tax exemptions, financial incentives, and subsidies for switching to solar energy take the credit for this change.

Nationwide adoption of solar energy solutions for government buildings and critical utility sector has also allotted domestic manufacturers the opportunity of growth.

However, government still needs to design and implement a larger policy framework, invest in R&D, and follow a globally accepted quality standards, if the country is to succeed utilizing their enhancing capacities.

Q: *This is a chicken and egg type issue since increased production would result in lower costs as well. Going beyond the already announced policy of a 100 GW target, what specific actions would increase market demand and uptake of solar panels?*

A: Indian solar players are aggressively enhancing their manufacturing capabilities in order to compete with foreign players in respect of manufacturing volume and price. However, present conditions can only be fruitful in presence of demand. Otherwise, manufacturers stand to suffer from inadequate Return On Investment (ROI).

This is where government can assist by creating demand. As a domestic manufacturer, Vikram Solar believes that clearing up confusion surrounding RPOs is necessary. Enforcing RPOs strictly with a stringent penalty structure and adding incentives in the equation can help RPOs turn into a functional component contributing to solar growth.

Bringing stability in solar tariff can pull in investors with assurance of handsome returns. Solar tariffs have already fallen below INR 5 a unit in November 2015. Decline in energy costs can undoubtedly bring us closer to reach nationwide grid parity, but continuous decline from this standpoint can dent India's investment climate.

Indian government also needs to work on raising awareness in work sectors and social communities to make solar energy more acceptable. Creating advertisement campaigns, establishing temporary or permanent solar museums, and organizing educational presentations can help in raising awareness, thus increasing market demand of solar modules.

Q: *What are the different issues affecting the quality of the modules available in the Indian market? Do you have concerns on the existing MNRE regulations on quality? If so, kindly explain. Are the existing GoI and private testing facilities adequate for the Indian market?*

A: Although the growth of solar module development in India is commendable (surpassing 6 GW energy generation capacity), most manufacturers are nowhere near matching the world accepted quality standards. Competition from foreign module manufacturers (especially China), lack of R&D support, slow infrastructural growth, and lack of uniform quality standard policy are few of the many issues that are keeping us from producing high quality modules.

Some manufacturers in India follow IEC and some follow BIS standards while there are many that do not adhere to any quality standards at all. Lack of quality control regulations can be blamed for such practices. We believe, India desperately needs to formulate and implement a set of guidelines not only controlling module standards

but also solar installations, and transportation cables to match global competitiveness.

Facilities for testing solar modules in India exist, which test around 150 modules annually and have a waiting list of over six months. The Electronics Test & Development Centre in Bengaluru and the Electronics Regional Test Laboratory in Kolkata are not functional due to a permission requirement, which is yet to be fulfilled. Therefore, India needs to actively undertake R&D platform installation right away.

However, MNRE has announced (in April 2016) plans towards setting up three committees to supervise and control quality of solar modules. This committee will also decide how many R&D platforms are needed across the country. Successful embedment of such procedures will be fruitful indeed.

Q: *Scale is one of the major factors for competitiveness. Given the domination of Chinese manufacturers (Yingli, Trina, etc.) both on scale and quality, how or what steps should Indian manufacturers take to compete in such an environment?*

A: Our Chinese competitors are backed by an incentivized development infrastructure, which allows them to sell their merchandise at a lower price than domestic manufacturers. This is undoubtedly quite the bump in the road to national solar growth.

However, we trust new policies in supporting quotas and mandating domestic manufacturer involvement in security or utility-based projects can translate into new opportunities. We would suggest domestic players to take advantage of International Solar Alliance, and gear up to cater to the solar demand of foreign countries.

On the other hand, Indian government must understand the need for ensuring protection and incentives to further solar growth. Policies focusing on such features can pull in investors in India to create financial balance within the industry, mitigating risk.

As a domestic manufacturer, Vikram Solar believes that competing with global players can help us grow only when our operations are guided by globally accepted roadmap/guidelines and backed by government support.

Consortium Leads

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

Research Thrust Leadership

Indian Institute of Technology Bombay, Center for 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

Indian Institute of Technology Madras, Indian Association for the Cultivation of Science, Arizona State University, Binghamton University, Carnegie Mellon University, Colorado School of Mines, Colorado State University, Massachusetts Institute of Technology, Purdue University, Stanford University, University of Central Florida, University of South Florida, Washington University in St. Louis, University of Colorado Boulder

Industry Partners

Bharat Heavy Electronics Ltd., Clique Developments Ltd., Eastman Kodak Company, Hindustan Petroleum Corporation Ltd., Infosys Ltd., Interphases Solar, Moser Baer India Ltd., Thermax Ltd., Wipro Ltd., Corning Research and Development Corporation, Semlux Technologies, Inc., Solarmer Energy, Inc., Sun Edison, Underwriters

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