

them forward. He said that insect taxonomists have now moved on to 'endangered' category, which needs to be remedied. He felt that public-private partnership is essential for the development of tasar silk sector.

C. Chattopadhyay (ICAR-National Research Centre for IPM) called for: (i) steps by the government for discouraging indiscriminate use of chemicals, pesticides and measures for filling in the lacunae in the registration of biopesticides and promotion of their use; (ii) IT-supported Integrated Design Support System for surveillance and management of insect pests through Good Agricultural Practices.

R. D. Gautam (IARI) highlighted some insect species of medicinal importance and appealed for documentation of indigenous knowledge and conservation of such species and desired co-ordinated efforts of State and Central Governments to check biopiracy. V. V. Belavady (UAS, Bengaluru) pointed out the impact of monocropping on pollinator diversity. He emphasized on assessment studies as well as conservation of pollinator diversity and numbers with powerful examples of impact of pollinators in crop productivity. S. Sithanandam (Sun Agro

Biotech Research Centre, Chennai) showed the potential of climate stress adapted *Trichogramma* species/strains for biocontrol of moth borers and emphasized on research for imparting insecticide tolerance to such biocontrol agents. Srinivasa Rao (CRIDA, Hyderabad) presented an analysis of the potential impact of climate change on insect pests and different adaptation strategies, and pointed out that we have a long way to go in understanding the pest scenario under climate change. T. V. K. Singh (PJTSAU, Hyderabad) provided insights into the insect resistance to *Bt* crops and underlined the need for in-depth studies to understand the mechanisms. R. K. Gupta (SKUAST Jammu) laid emphasis on Entomophage Insect Park through introduction of suitable plant species for *in situ* establishment of insect enemies of crop pests.

Vasantharaj David made an extensive coverage of various edible insect species in India as well as across the world. He said promotional drives are needed to change the general negative attitude towards inclusion of insects in the diet. In view of changes witnessed in pest scenario, he desired preparation of crop-specific insect pest calendars.

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R. Ramani*, **K. K. Sharma, Md. Monobrullah** and **A. Mohanasundaram**, ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi 834 010, India.

*e-mail: ramani_9@consultant.com

MEETING REPORT

Is solar power cheaper than coal?*

In the last few years, the cost of grid-connected solar photovoltaic (PV) power has come down drastically. There is strong evidence from international studies that the levelized cost of solar power is on par with coal-fired power plants when the cost of externalities (greenhouse gas emissions, air pollution and ash disposal) is taken into account. A one-day workshop was held recently to explore how far these cost trends of solar and coal-fired power plants are valid in the Indian context. The workshop was

targeted at various players in the power sector, such as decision-makers, bureaucrats, think-tanks, power generation and distribution companies, academic institutes and grass-root organizations.

In his keynote address, Baldev Raj (NIAS) highlighted the importance and challenges of sustainable energy generation in the Indian context. Then, J. Srinivasan (Divecha Centre for Climate Change, IISc) introduced the objectives of the workshop. He highlighted the growth of solar PV technology in recent years; the technology once considered as expensive and impractical has now become promising and viable. In contrast, coal and nuclear technologies which were considered as promising technologies till recently, have become expensive.

Akhilesh Magal (Gujarat Energy Research and Management Institute) gave a

talk on 'A market view on solar PV in India'. He showed that the share of private projects in total installed solar capacity was 34%, with the remaining share coming from state (37%) and national (29%) projects. Solar PV installations have grown from 25 MW in 2011 to 4114 MW in 2015. The market-driven price model adapted in India has translated into record-low solar tariffs; the lowest price bids in 2015 have ranged from 5.05 to 5.25 INR/kWh. Magal concluded his talk with the following comments: "Business as usual" is dangerous for India's power utilities; both utility scale solar and rooftop will revolutionize the way we think of power'.

Sharath Rao (Centre for Study of Science, Technology & Policy) gave a presentation on 'Is the current PV price sustainable?' He showed that the

*A report on the workshop organized by Divecha Centre for Climate Change, Indian Institute of Science, Bengaluru and National Institute of Advanced Studies (NIAS), Bengaluru on 'Is power generation by solar cheaper than from coal?' on 8 August 2015 at NIAS.

manufacturing cost of PV modules in India is around 0.75 \$/W_p compared to 0.55 \$/W_p in China, which is mainly because of higher manufacturing costs of PV cells in India. He concluded that the aggressive bidding by developers might be a concern, but Government incentives are key to the growth of solar PV market.

Karthik Ganesan (Council on Energy, Environment and Water) gave a talk on 'Contribution of renewable energy and fossils to India's energy mix: a view from two scenarios'. He argued that coal is important even in any scenario which tries to actively curtail emissions. Higher levels of emissions reduction imply that coal will increasingly be replaced – not just by solar, but by natural gas, wind and nuclear power. The best replacement options for coal exist mainly in the power sector, but industry still continues to consume a significant amount of coal. Variability associated with renewable energy sources will necessitate the creation of capacity that is more readily dispatchable. A conventional cost-effective option is back-up coal or natural gas to keep flexibility within constraints.

Rahul Tongia (Brookings India) presented a talk entitled 'Coal, solar, and more – thinking of the future of the grid'. He argued that, in terms of grid stability, India's grid with 6% renewable energy is equivalent to Germany's at 25%. Renewable energy resources are concentrated in a handful of states and it may not contribute to the peak load in the evening. He highlighted the operational, financial

and transmission problems we will face if the installed capacity of renewable energy increases by 50%.

Ajit Kolar (Indian Institute of Technology Madras) presented a talk on the performance of advanced coal technologies. He asserted that a judicious mix of all energy sources (fossil and renewable) will be essential for sustainable power generation at the national level, and presented a case of projected high renewable scenario in 2035, wherein coal power still dominated the power generation mix. The characteristics of potential advanced coal technologies in terms of heat release with pollutant reduction, more heat utilization and emission control accessories were briefly discussed. He made a case for the indigenous development of clean coal technologies.

Sarath Guttikunda (Urban Emissions) gave a talk on the impact of coal power generation in India on air pollution and health. Coal power generation accounted for 73% of total Indian electricity generation in 2014–15. However, the particulate emissions from coal-fired power plants resulted in an estimated 80,000–115,000 premature deaths in 2011–12 alone. The primary reason for higher concentration of sulphur dioxide and nitrogen oxides in particulate emissions from Indian coal power plants is due to the lack of flue-gas desulphurization. He pointed out that Indian particulate emission standards considerably lag behind those implemented in China, USA and EU. He concluded by making a case for

continuous power plant-level emission monitoring, and better regulations and implementation.

Mitavachan Hiremath (Centre for Sustainability, Policy and Technology Management) and Shoibal Chakravarty (NIAS) presented a talk on 'True costs of coal and solar power generation'. The presentation started with a brief summary on the levelized cost (LCOE) of coal and solar power generation in today's Indian market. The recent solar bids in Madhya Pradesh and Telangana were around INR 5.05–5.74 per unit; on the other hand, the recent coal bids in Andhra Pradesh varied from INR 4.27 to 7.1/kWh. Further, according to international studies, pollution and other externalities add around INR 4.4–12.6 per unit of electricity generated in case of coal and INR 0.8–1.5 in case of solar power generation. Chakravarty highlighted the risks, systemic externalities and external factors to achieve 100 gigawatts of solar power by 2022. The talk concluded that we need social and environmental cost-benefit analyses, including externalities, for all energy sources in the Indian context.

H. Mitavachan*, Centre for Sustainability, Policy and Technology Management, Bengaluru 560 012, India; **Shoibal Chakravarty**, National Institute of Advanced Studies, Bengaluru 560 012, India.

*e-mail: mitavachan@gmail.com

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