

# ***TECHNOLOGY AND BUSINESS CHALLENGES IN SOLAR PHOTOVOLTAIC TECHNOLOGIES***

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## **ABSTRACT**

The fact that SUN can provide an unlimited source of clean energy in terms of both heat and light has been recognized for a long time, ever since the discovery of photoelectric effect by Albert Einstein and the demonstration of the first Silicon based solar cell at Bell Laboratories in the early fifties. Yet, the momentum towards the utilization of sun's light for generation of electricity is a recent phenomenon, accelerated by the scaling up of solar silicon manufacturing in China coupled with a large demand for solar electricity worldwide. This has led to precipitous drop in the cost of solar power generation to about 30 US cents per watt at the cell level and 70 US cent per W at the module level. The price of poly-silicon has crashed from US\$ 400 in 2008 to less than US\$ 15 per kg today. In view of this utility scale solar photovoltaic (PV) installations are becoming competitive with coal and gas-fired power plants based on a leveled cost of electricity.

India has emerged as the third largest market for solar electricity with a capacity of 9 GW in 2017 as against a demand of 52 GW in China and 12 GW in the USA. Imported modules will meet much of India's demand, with opportunities only for integration and erection for Indian entrepreneurs. We do not seem to have any specific policy initiatives for large scale manufacturing in India in this sector. The Government's recent decision to levy an import tariff on modules to protect the domestic industry is unlikely to be useful, since India does not have adequate capacity for manufacture of solar modules to meet its projected growth of solar electricity generation. Under the prevailing circumstances, we are unlikely to see a large capital infusion in this area in the foreseeable future.

There are both risk and opportunities in ceding the future of our energy from sun, once again, to technology and products available outside of India.

Emerging photovoltaic (PV) technologies based on dye sensitized solar cells, organic compounds, perovskite materials and quantum dots have been stimulating intense R&D efforts in academia and industry and attracted significant attention in scientific press. They have also attracted large public as well as venture capital funding across the globe and have spawned many new technology driven start-ups, many of which are in the early stages of evolution. The promise of second and third generation PV technologies appear attractive because they are thinner, flexible, work in diffuse light, easy to fabricate, provide unlimited design freedom and may be more inexpensive. This opens up many new applications beyond rooftop and solar-farm panels, which dominate silicon, based PV applications today.

However, most of these technologies are at a research level with a few start-ups trying to create marketable technologies. The journey from the laboratory to market has been painfully slow.

In my presentation, I will address the following issues:

1. What are the risks and opportunities with silicon PV electricity generation in India based solely on supplies from outside? What will be our future vulnerabilities in terms of energy security ?
2. What features of silicon PV technology are likely to be limiting for emerging PV applications?
3. Given that polycrystalline silicon based PV is a mature workhorse technology, where can Indian entrepreneurs create value beyond utility scale power generation?
4. What are the barriers in commercialization of established and emerging PV technologies?
5. Strategies for new product development and application of PV technologies