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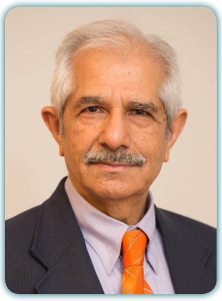

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Materials and processing opportunities and challenges for transformation of global electricity infrastructure

Free fuel based conversion of solar energy and wind energy into electrical power is the only long term solution for providing sustainable global economic growth. There is no direct competition between solar energy (available during day time) and wind energy (mostly available during night times), however direct solid state conversion of solar energy by photovoltaics (no moving parts) has distinct advantages over electrical power generated by wind turbines. With the advent of low-cost solar panels, and our ability to generate, store and use electrical energy locally without the need for long-range transmission, the world is about to witness transformational changes in electricity infrastructure. Semiconductor manufacturing has played a vital role in enabling the communication revolution that started in the last half of the 20th century and is continuing to shape the world of tomorrow. Since the energy crisis of 1973, the cost of photovoltaics (PV) modules has decreased approximately exponentially and the global photovoltaic installations have increased approximately exponentially (cumulative global PV installation of 230 GW by the end of year 2015). In addition to the advancements in the technology of PV module manufacturing, volume manufacturing has played a vital role in the cost reduction. Doubling the cumulative manufacturing size reduces the cost of PV modules by about 24%. Unlike integrated circuits and solar cells, batteries are not semiconductor products. However, due to supply chain related issues, connecting various cells to form batteries (similar to ICs and PV modules where number of devices are integrated to form a product), important role of surfaces and interfaces in controlling device performance, reliability and yield, use of thermal processing steps similar to semiconductor manufacturing and PV manufacturing, the battery manufacturing is following the cost reduction path of semiconductor related products. More than 90% of the PV market is based on bulk silicon solar cells. The highest efficiency of silicon modules is about 21.5% efficiency, which is not too far than about 30% energy conversion efficiency of centralized electrical power generation by nuclear, coal and natural gas. The key objective of this paper is to demonstrate the opportunities and challenges for materials and processing researchers in the area of solar cells and batteries manufacturing. The contributions of materials researchers can lead to technological advancements that will accelerate the pathways for sustained global economic growth for underdeveloped, emerging and developed economies. In addition, the continuous decrease in the cost of photovoltaics (PV) generated and stored local electricity is now making it possible to provide electrical energy to over 3.5 billion people globally who previously had little or no access to electricity.

Biography

Rajendra Singh is D. Houser Banks Professor in the Holcombe Department of Electrical and Computer Engineering and Director of Center for Nanoelectronics at Clemson University. During Oil embargo of 1973, he decided to do his PhD dissertation in the area of Silicon Solar Cells. With proven success in operations, project/program leadership, R&D, product/process commercialization, and start-ups, Dr. Singh is a leading semiconductor and photovoltaics (PV) expert with over 37 years of industrial and academic experience. His current research interest is to provide global leadership in phasing out alternating current based grid by PV generated local direct current based power networks. He is fellow of IEEE, SPIE, ASM and AAAS. Dr. Singh has received a number of international awards. Photovoltaics World (October 2010) selected him as one of the 10 Global "Champions of Photovoltaic Technology". Dr. Singh is 2014 recipient of the SPIE Technology Achievement Award On April 17, 2014 he was honored by US President Barack Obama as a White House "Champion of Change for Solar Deployment" for his leadership in advancing solar energy with PV technology.

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