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High-Efficiency, Multijunction Solar Cells for Large-Scale Solar Electricity Generation

SARAH KURTZ, National Renewable Energy Laboratory

A solar cell with an infinite number of materials (matched to the solar spectrum) has a theoretical efficiency limit of 68%. If sunlight is concentrated, this limit increases to about 87%. These theoretical limits are calculated using basic physics and are independent of the details of the materials. In practice, the challenge of achieving high efficiency depends on identifying materials that can effectively use the solar spectrum. Impressive progress has been made with the current efficiency record being 39%. Today's solar market is also showing impressive progress, but is still hindered by high prices. One strategy for reducing cost is to use lenses or mirrors to focus the light on small solar cells. In this case, the system cost is dominated by the cost of the relatively inexpensive optics. The value of the optics increases with the efficiency of the solar cell. Thus, a concentrator system made with 35%- 40%-efficient solar cells is expected to deliver 50% more power at a similar cost when compare with a system using 25%-efficient cells. Today's markets are showing an opportunity for large concentrator systems that didn't exist 5-10 years ago. Efficiencies may soon pass 40% and ultimately may reach 50%, providing a pathway to improved performance and decreased cost. Many companies are currently investigating this technology for large-scale electricity generation. The presentation will cover the basic physics and more practical considerations to achieving high efficiency as well as describing the current status of the concentrator industry.