

RAPID GROWTH AND REMAINING CHALLENGES FOR SOLAR PHOTOVOLTAIC TECHNOLOGY

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Solar photovoltaic technology has advanced very rapidly and now provides several percent of electricity in some countries with around 10% of electricity coming from solar energy in several countries and more than 17% in the state of California. The absolute growth in China far exceeds that of any other country as China rapidly expands its electrical infrastructure including both utility-scale and rooftop solar energy and an upgraded transmission system. Rapid cost reduction has caught much of the world by surprise and growth has consistently exceeded the majority of published projections. The IEA's World Energy Outlook 2017 highlights the impressive reduction in cost of solar energy and suggests that faster growth of the solar industry can be expected. A growing number of projects have been negotiated with prices in the 2-4 US cents/kWh range. While sales are dominated by crystalline silicon modules, numerous solar cell materials and structures continue to be researched and both cell and module efficiencies are increasing. Perovskite solar cells have created recent excitement with development of this entirely new material taking place in a much shorter time than any other technology and an unstabilized efficiency of 22.7% now demonstrated. Silicon module technology continues to evolve rapidly both through changes in module technology, such as glass-glass module construction and in cell technology, with a rapid adoption of PERC cells now anticipated. Cadmium telluride and copper indium gallium selenide thin-film technologies provide an alternative approach and are also advancing rapidly, though thin-film technologies overall have lost market share in the last ten years, despite their continued growth. Solar systems have demonstrated lifetimes greater than 30 years and low degradation rates (often < 1%/year). Solar systems are now beginning to be paired with battery storage so as to extend the hours during which electricity can be delivered. Continued reduction of cost of the solar systems is needed to make room for the additional cost of the storage while still delivering the electricity at a competitive price. As prices are pushed to extremely low levels, the 30 year or longer lifetimes may be challenged and risk assessment associated with new failure mechanisms or lack of quality control is a continuous challenge. Continued growth on current trajectories could enable solar electricity to reach 3-10 TW installed capacity by 2030.