

# THE CHANGING FACE OF SOLAR ENERGY

August 2024

**Solar energy is developing fast across many areas of the world. Many new developments are both exciting and offer the potential to transform the use of solar power. However, challenges remain.**

## The latest developments

**Perovskite Solar Cells:** Research is making advances into perovskite solar cells, which have the potential to be more efficient and cost-effective than traditional silicon-based cells. New methods to improve the stability and efficiency of these cells, such as using dimethylammonium formate to inhibit halide oxidation, are being explored

**Tandem Solar Cells:** triple-junction tandem solar cells: researchers from the National University of Singapore have developed cells that combine different materials to achieve incredible efficiencies. These cells integrate ultrawide bandgap perovskites, which allow for better light absorption and conversion rates.

**Space-Based Solar Panels:** There is increasing interest in the potential of space-based solar panels, which could capture sunlight without atmospheric interference and transmit energy back to Earth. This technology is still in the experimental phase but holds promise for future large-scale renewable energy production

**Bifacial Solar Panels:** Many locations are adopting bifacial solar panels, which can capture sunlight from both sides, increasing overall energy generation. These panels are particularly effective in environments where light can reflect off surfaces like snow or sand/rock

## The reducing cost of solar energy

The cost of solar energy continues to reduce. As of 2024, the average cost of solar panel installation in the U.S. is around \$3.40 per watt, which includes both hardware and soft costs like labor, financing fees, and permitting requirements.

The cost of solar installations can also vary widely depending on several factors, including the type and brand of equipment, location characteristics, and additional costs like maintenance, financing fees, and potential electrical panel upgrades.

## Solar energy is not without challenges

**Intermittency:** Solar energy generation is dependent on weather conditions and daylight hours. Cloud cover, nighttime, and seasonal variations can significantly impact the amount of energy produced. This intermittency makes it difficult to rely solely on solar power without substantial energy storage solutions or backup systems.

**Energy Storage:** To mitigate the intermittency of solar power, efficient and cost-effective energy storage systems are required. Current battery technologies, like lithium-ion batteries, are still expensive and have limitations in terms of capacity and lifespan. Advancements in energy storage are crucial for the broader adoption of solar power

**High Initial Costs:** The upfront cost of installing solar panels can be prohibitive as compared to more traditional energy sources. Although the prices of solar panels have decreased over the years, the initial investment remains a barrier.



**Space Requirements:** Solar installations, especially for large-scale utility projects, require significant amounts of land. Finding suitable locations that do not conflict with agricultural, residential, or ecological interests can be challenging. Rooftop solar panels are a solution for residential and commercial buildings, but they may not be sufficient for large energy demands.

**Efficiency and Technological Limitations:** While solar panel efficiencies have improved, they are still not 100%. Current commercial solar panels convert about 15-20% of the sunlight they receive into electricity. Continued research is needed to develop more efficient materials and technologies to maximize energy capture.

**Grid Integration:** Integrating solar power into the existing electricity grid presents technical challenges. The grid must be capable of handling fluctuations in solar power output and managing the distributed nature of solar energy systems. Upgrading grid infrastructure to accommodate renewable energy sources can be costly and complex.

**Environmental Impact:** The production and disposal of solar panels have environmental implications. Manufacturing solar panels involves hazardous materials, and improper disposal can lead to environmental contamination. Developing sustainable practices for the entire lifecycle of solar panels is essential to minimize their environmental footprint.



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