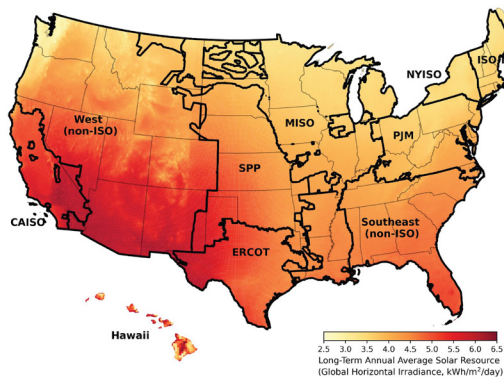


Solar PV Energy

Solar energy can be harnessed two primary ways: PVs are semiconductors that generate electricity directly from sunlight, while solar thermal technologies use sunlight to heat water for domestic uses, to warm buildings, or heat fluids to drive electricity-generating turbines. This factsheet examines only photovoltaic (PV) systems. Solar technology generated 6.7% of U.S. electricity in 2025.² Solar PV uses 3.2% of the land as corn ethanol to produce the same amount of energy.¹

Annual Average Solar Radiation in the U.S.³



Solar Resources and Potential

- On average, 173,000 TW of solar radiation continuously strike the Earth,⁴ while global electricity demand averages 3.1 TW.⁵ The solar resource is 55,800x the current demand.
- Electricity demand peaks at different times than PV generation, creating energy surpluses and deficits. Energy storage and demand management help match PV generation with demand.⁶ See the [U.S. Grid Energy Storage Factsheet](#) for more information.
- The solar energy resource at the earth's surface is 1,000 watts per square meter, enough to power a microwave if all the energy was converted to electricity.^{7,8}
- PV conversion efficiency measures the percentage of solar energy converted to electricity.⁹ While most available solar panels achieve ~20% efficiency,¹⁰ researchers have developed experimental modules approaching 50%.¹¹
- Net energy ratio compares an energy system's life cycle energy output to its life cycle primary energy input. Silicon PV panels generate 7.2x to 11.4x more energy than is required to produce them.^{12,13}

PV Technology and Impacts

PV Cells

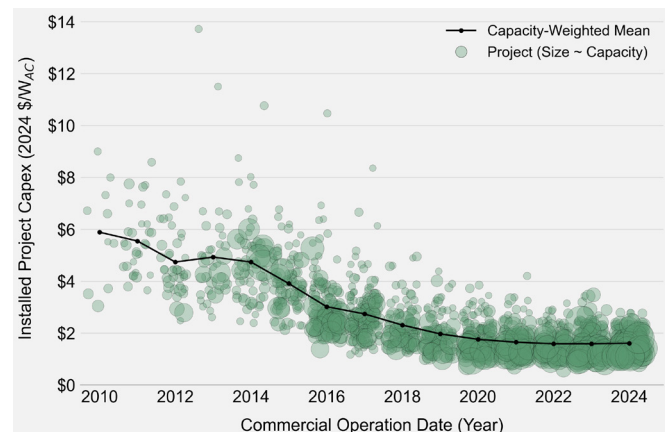
- PV cells are made of semiconductor materials that free electrons when struck by light, producing electrical current.¹⁴ Various materials can be used, including silicon, copper

indium gallium diselenide (CIGS), cadmium telluride (CdTe), perovskites, and organic compounds (OPV).¹⁴ PV cells also include electrical contacts that allow electrons to flow to the load and surface coatings that reduce reflection.¹⁴

PV Modules and Balance of System (BOS)

- PV modules typically comprise 60-72 cells arranged in a rectangular grid, laminated between transparent front and structural back surfaces. They usually have metal frames and weigh 34-62 lb.¹⁵ A PV array is a group of electrically connected modules fastened to a rigid structure.¹⁶
- BOS components include all necessary elements beyond PV panels: connecting wires, junction boxes, mounting hardware, and power electronics that manage array output.¹⁶
- Crystalline silicon (c-Si) is the dominant module technology in the U.S. and globally. Commercialized alternatives include cadmium telluride (CdTe) and copper indium-(gallium)-diselenide (CIGS/CIS) thin-film modules.¹⁷
- Cost efficiency (cost per watt) matters more than conversion efficiency for most applications. In the U.S., PV systems had a modeled market price (MMP) of \$1.12 to \$3.15 / W_{DC} in 2024.¹⁸

Utility PV Capital Expense (2024\$/ W_{AC})³

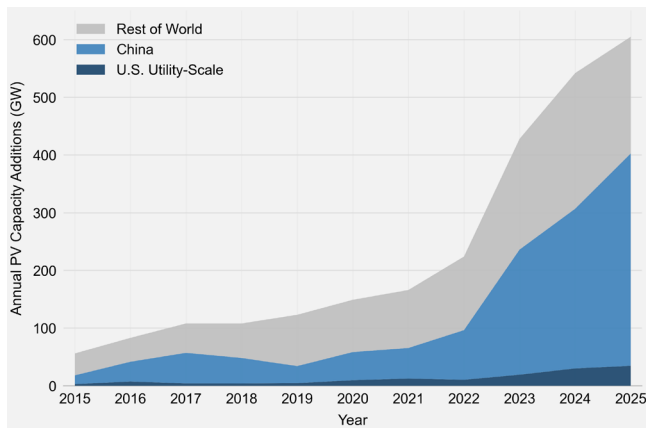


- Bifacial PV modules capture sunlight on both sides, increasing energy production up to 15% over single-sided modules.¹⁹ The global market share of bifacial PV modules was 12% in 2020, and is projected to reach 30% by 2030.²⁰
- Tracking systems that can follow the sun through the day have become increasingly attractive for ground-mounted systems, despite upfront cost premiums. Tracking systems increase energy production 15-35% (single-axis) to 25-50% (dual-axis) over fixed-tilt systems.¹⁹ In 2024, 99% of new U.S. capacity used tracking.³
- Building Integrated PV (BIPV), such as solar shingles, replaces building materials and improves PV aesthetics.²¹

PV Installation, Manufacturing, and Cost

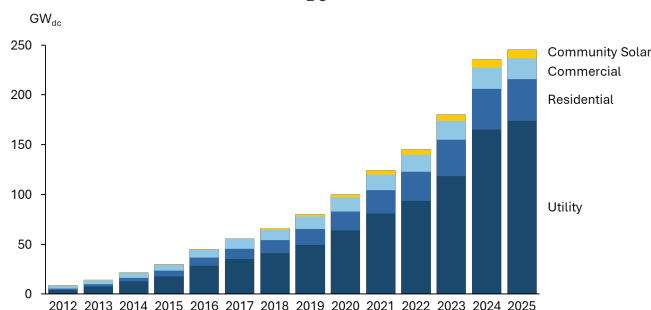
- PV capacity additions grew 12% in 2025, and accounted for 76% of all new renewable capacity globally.²² Solar provided 46% of renewable electricity generation and 7% of global electricity production in 2024,²³ up from 5.5% in 2023.²⁴
- In 2025, global PV power capacity grew by 605 GW to reach 2.8 TW.²² Global solar capacity is set to exceed 7 TW by 2030.²³
- The top installers in 2025 were China (328 GW), India (48 GW), the U.S. (43 GW).²² U.S. residential solar added 4.6 GW in 2025, compared to 34.7 GW from utility-scale solar.²⁵

Global PV Capacity Additions (GW)^{3,22,32}

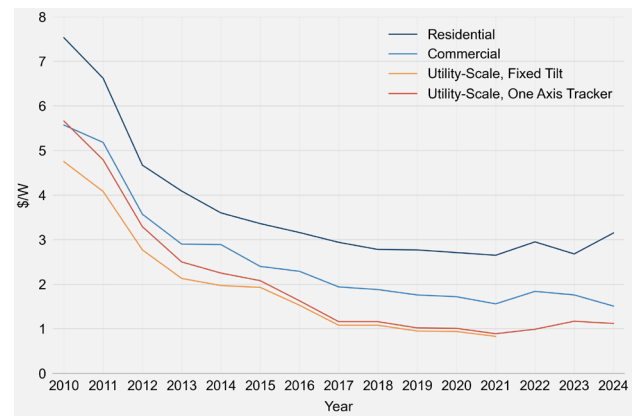


- New U.S. power purchase agreement (PPA) prices increased 14% from 2023 to 2024, partially due to more high-priced regions buying power.³ Driven by lower capital costs and higher capacity factors, the average levelized cost of energy (LCOE) for utility-scale solar PV dropped by 77.5% since 2010.³
- The average U.S. utility solar project in 2024 has 5x the capacity of an average 2017 project.³
- Significant disruptions in global supply chains over the past three years contributed to a rise in LCOE to 6.1¢/kWh in 2024 before falling to 5.8¢/kWh in 2025.^{24,26}
- Global solar investment has been >\$300B per year since 2022, almost double any other generation technology.²⁸
- The U.S. has 3.2 GW of solar cell manufacturing capacity.²⁷

U.S. Solar Capacity (GW_{DC})³³



Median Installed PV System Price in the U.S. (\$/W)^{18,34}



- Utility PV was >50% of new U.S. capacity in 2024.³ Solar and storage represented 91% of new capacity in the first quarter of 2026.²⁹
- In 2024 there were 280,119 solar workers in the U.S.³⁰ compared to 44,060 employees at U.S. coal mines.³¹

Environmental Impacts

- Designing for end-of-life could improve the current 10% recycling rate of PV modules,³⁵ which could lead to a 42% reduction in lifecycle GHGs.³⁶
- Monocrystalline silicon emits 14 to 72 g CO₂e per kWh produced^{13,36}—far below coal's 1,001 g CO₂e/kWh.³⁷ 71.3% of PV GHG emissions come from manufacturing.³⁶
- PVs use significantly less water to generate electricity (87 gal/MWh) compared to non-renewables like coal (586 gal/MWh).³⁶

Solutions and Sustainable Actions

- The Inflation Reduction Act of 2022 provided a 30% Investment Tax Credit and Production Tax Credit of 2.75¢/kWh for qualified solar systems through 2027.^{38,39}
- Check the [DSIRE database](#) or contact your state energy agency for more incentives on your solar installation.⁴⁰
- Those without access to roof space for PV panels can join community solar programs, which are local projects that share ownership and receive credit on their electricity bills.⁴¹
- Most states, including D.C., have at least one community solar project online, with 7.87 GW U.S. capacity.⁴² 14 states and D.C. have mandates that a portion of community solar must serve lower and middle income (LMI) customers.⁴² 12 states and D.C. have legislated financial support for LMI customers.⁴²
- In 2022, 32% of U.S. utility green pricing, voluntary programs to source renewable energy through a customer's default utility, was solar power.^{43,44}
- Solar REC (SREC) markets require electricity suppliers to purchase SRECs from in-state solar systems as part of their obligation under state Renewable Portfolio Standards.⁴⁵ As of 2026, DC, DE, IL, MD, OH, and PA provide SREC programs.⁴⁶