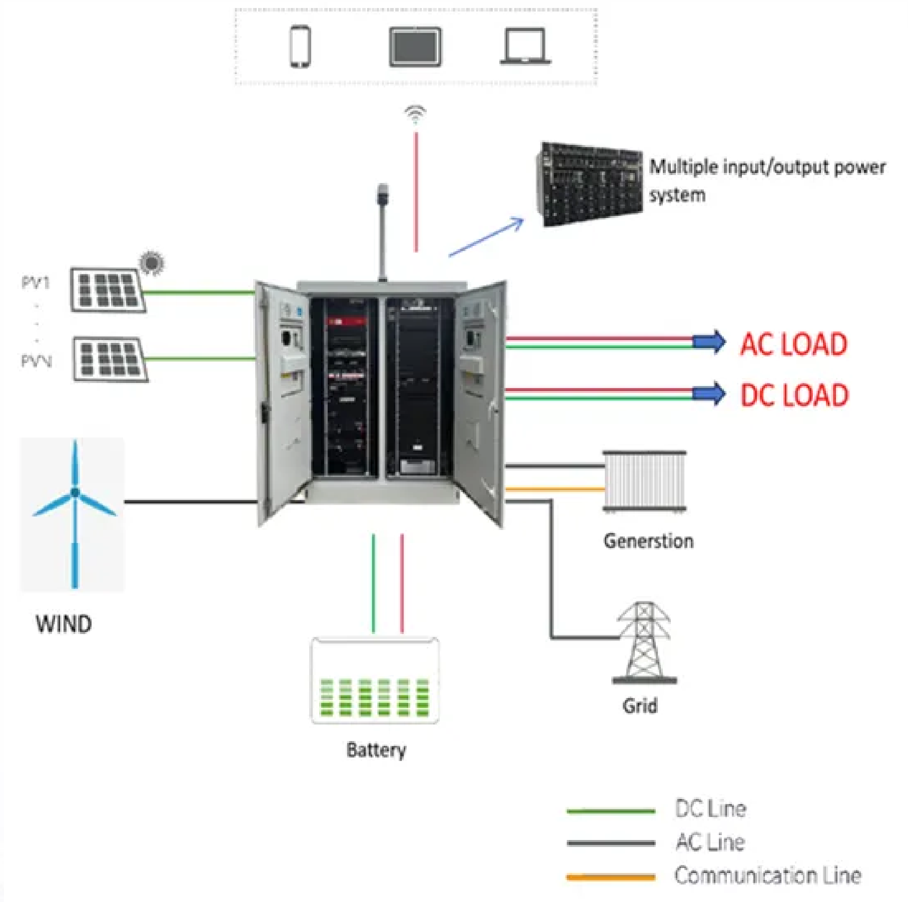
ContainerPower Energy Solutions

Cadmium telluride thin-film solar modules



Overview

Cadmium telluride (CdTe)-based cells have emerged as the leading commercialized thin film photovoltaic technology and has intrinsically better temperature coefficients, energy yield, and degra.

Cadmium telluride (CdTe) photovoltaics is a (PV) technology based on the use of in a thin layer designed to absorb and convert sunlight into electricity. Cadmium telluride PV is the only Cadmium telluride (CdTe) photovoltaics is a (PV) technology based on the use of in a thin layer designed to absorb and convert sunlight into electricity. Cadmium telluride PV is the only with lower costs than conventional made of in multi-kilowatt systems. On a lifecycle basis, CdTe PV has the smallest , lowest water use and shortest of any current photovoltaic technology. CdTe's energy payback time of less than a year allows for faster carbon reductions without short-term energy deficits. The toxicity of is an environmental concern during production and when the.

The dominant PV technology has always been based on wafers. and were early attempts to lower costs. Thin films are based on using thinner layers to absorb and convert sunlight. Concentrators lower the number of panels by using lenses or mirrors to put more sunlight on each panel. The first thin film technology to be extensively developed was . However, this technology suffers from low efficiencies and slow deposition rates (leading to high capital costs). Instead, the PV market reached some 4 gigawatts in 2007 with crystalline silicon comprising almost 90% of sales. The same source estimated that about 3 gigawatts were installed in 2007. During this period cadmium telluride and or CIS-alloys remained under development. The latter is beginning to be produced in volumes of 1–30 megawatts per year due to very high small-area cell efficiencies approaching 20% in the laboratory. CdTe cell is approaching 20% in the laboratory with a record of 22.1% as of 2016.

Research in CdTe dates back to the 1950s, because its band gap (~1.5 eV) is almost a perfect match to the distribution of photons in the solar spectrum in terms of conversion to electricity. A simple design evolved in which p-type CdTe was matched with n-type (CdS). The cell was completed by adding top and bottom contacts. Early leaders in CdS/CdTe cell efficiencies were in the 1960s, and then , Monosolar, , and AMETEK. By 1981, Kodak used (CSS) and made the first 10% efficient cells and first multi-cell devices (12 cells, 8% efficiency, 30 cm). Monosolar and AMETEK used , a popular early method. Matsushita started with but shifted in the 1990s to CSS. Cells of about 10% sunlight-to-electricity efficiency were produced by the early 1980s at Kodak, Matsushita, Monosolar and AMETEK. An important step forward occurred when cells were scaled-up in size to make larger area products called modules. These products required higher currents than small cells and it was found that an additional layer, called a (TCO), could facilitate the move.

In August 2014 First Solar announced a device with 21.1% . In February 2016, First Solar announced that they had reached a record 22.1% conversion efficiency in their CdTe cells. In 2014, the record module efficiency was also raised by First Solar from 16.1% up to 17.0%. At this time, the company projected average production line module efficiency for its CdTe PV to be 17% by 2017, but by 2016, they predicted a module efficiency closer to ~19.5%. To reach these record high efficiencies of 22%, alloying is used for band gap grading. A compound incorporating selenium into CdTe is used in the solar cell to improve the quantum efficiency response for certain wavelengths of light, in addition to unalloyed CdTe. The other major contributor to this large increase in efficiency is the usage of MgZnO (MZO) within the cell. In a cell using a $CdSe_xTe_{1-x}$/CdTe structure, MZO can be used in place of CdS. CdS is source of inefficient absorption, while MZO has a tunable band gap that can be optimized for high transparency and good alignment with $CdSe_xTe_{1-x}$. Process optimization improved throughput and lowered costs. Improvem.

, a considered a hazardous substance, is a waste byproduct of mining, smelting and refining sulfidic ores of zinc during , and therefore its production does not depend on PV market demand. CdTe PV modules provide a beneficial and safe use for cadmium that would otherwise be stored for future use or disposed of in landfills as hazardous waste. Mining byproducts can be converted into a stable CdTe compound and safely encapsulated inside CdTe PV solar modules for years. A large growth in the CdTe PV sector has the potential to reduce global cadmium emissions by displacing coal and oil power generation. production and reserves estimates are subject to uncertainty and vary considerably. Tellurium is a rare, mildly toxic metalloid that is primarily used as a machining additive to . Te is almost exclusively obtained as a by-product of copper refining, with smaller amounts from lead and gold production. Only a small amount, estimated to be about 800 metric tons per year, is available. According to , global production in 2007 was 135 metric tons. One gigawatt (GW) of CdTe PV modules would require about 93 metric tons (at current efficiencies and thicknesses). Through improved and increased PV recycling, the CdTe PV industry has the potential to fully rely on tellurium from recycled end-of-life modules by 2038. In the last decade , new supplies have been located, e.g., in Xinju, China as well as in Mexico and Sweden. In 1984 astrophysicists identified tellurium as the universe's most abundant element having an over 40. Certain undersea ridges are rich in tellurium. The manufacture of a CdTe cell includes a thin coating with ($CdCl_2$)

to increase the cell's overall efficiency. Cadmium chloride is toxic, relatively expensive and highly soluble in water, posing a potential environmental threat during manufacture. In 2014 research discovered that abundant and harmless

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