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Title: -

Solar Energy Harvesting

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Solar Energy Harvesting

Solar energy harvesting is most commonly associated with the **solar panels** you see sitting on residential rooftops. However, the commercialized adoption of solar energy harvesting spans a variety of applications that provide astounding amounts of energy to the world

1) Photovoltaic Solar Panels

Photovoltaic (PV) solar panels use the sun's power to create a flow of electricity. This is the most widely adopted method of harvesting solar energy today. These panels, which range in size from a few square centimeters to a few square meters, are constructed from many PV cells arranged in an intricate matrix. Intuitively, the larger the surface area available for sunlight to penetrate the PV cells, the more solar energy that gets harvested.

Each PV solar cell is generally made up of a compound semiconductor wafer structure, which can either be a monocrystalline or polycrystalline structure. The structure's two thin semiconductor wafers, one P-type and one N-type, are each grown separately. The two wafers are placed on top of each other, and the natural reaction that occurs between the two semiconductor types creates a depletion zone that reaches an equilibrium point, without generating any electricity. Due to the PV cell, when light photons pass through and connect with the semiconductor wafers, their interaction releases enough energy to create an equilibrium disruption in the depletion region. That action subsequently creates a brief flow of electricity. However, because of the constant presence of light, this interaction occurs continuously and can produce massive amounts of electrical energy.

The power produced by a single photon interaction replicates across the entire surface of the PV cell. It's compounded into a whole panel of solar cells and then

into a vast PV panel array. This minor interaction in the depletion zone can be repeated and multiplied, resulting in a significant amount of electricity. PV solar arrays, however, produce DC power. To be integrated with modern power transmission technology, such as the outlets in your home, this DC energy must be converted to AC power using an inverter. There are a variety of proprietary iterations of this fundamental technology that seek to optimize the efficiency of each PV cell on a molecular level, the assembly of the panel, and the panel's ability to be integrated into a larger solar array.

2) Thermal Energy Harvesting: Energy of Electromagnetic Radiation

The sun produces a broad spectrum of radiation of many different wavelengths, including infrared. This spectrum efficiently transfers thermal energy to bodies that can absorb it. Elements that can effectively absorb this thermal electromagnetic energy are referred to as 'black bodies,' as the color black absorbs all wavelengths of radiation that are visible to the human eye. An ideal black body can correctly absorb, and emit, all wavelengths of the electromagnetic radiation spectrum. Electromagnetic radiation has long been used for heating in many passive heating systems, such as the egg cooking example, in Roman bathhouses and Ancient Egyptian homes, and modern solutions such as thermal solar panels and thermosiphons. These thermal solar energy harvesting strategies rely heavily on black body radiation physics and their ability to absorb and transfer electromagnetic radiation. On a residential level, thermal energy is gathered most often for use in water heating systems. However, these solutions are less suitable for energy generation on an industrial scale.

3) Solar Water Heaters

A great example of a thermal solar energy harvesting application that's commonly implemented in sunny climates around the globe is a solar water heater. The simplest version of a solar water heater system uses a pump to circulate cool water through a black body panel. This visually resembles a PV solar panel, where the black surface efficiently absorbs thermal energy, which is then cooled by the circulated water, thereby heating the water. The water is continually circulated through this loop, creating warm water throughout the solar activity. Some systems can forgo a pump system by utilizing the buoyancy created by the heated water. This warmer water 'floats' and the colder water sinks, producing low amounts of flow in the system, creating a thermosiphon. These systems require the storage tank to be above the solar absorption source, as shown here.

4) Vacuum Tube Solar Water Heater

More advanced and efficient solar water heating systems utilize vacuum tubes and self-contained heat pipes to transfer thermal energy to a secondary tank. The vacuum tube ensures that radiant energy can enter the system, but all energy that gets turned into thermal energy is contained in the tube. The heat pipe absorbs this energy and subsequently transfers it to the large water tank. These systems are significantly more efficient at heating water during cold months, as minimal amounts of thermal energy escape the vacuum tube, allowing nearly all radiant energy to be converted into thermal energy.

5) Molten Salt Solar Power

Relatively recent breakthroughs in molten salt systems are pushing the boundaries of power generation using solar energy. However, much like the previously discussed solar-powered water heating systems, molten salt power plants utilize electromagnetic radiation to melt salt. This molten salt then gets transferred to a heat exchanger, which heats water into steam that is then driven through a steam turbine to generate electricity. Molten salt power plants, such as the Ivanpah Solar Plant, rely on an extensive network of heliostat mirrors to redirect sunlight to a single point, most often referred to as a power tower or central tower. This tower collects the energy from all surrounding heliostats, which is enough power to melt

the salt at nearly 1500°F. This molten salt is then stored in insulated tanks, allowing for the energy to be used even when the sun is no longer shining.

Advantages of Solar Energy

1. Renewable Energy Source

The most significant thing of all the advantages of solar panels is that solar energy is a genuinely sustainable source of energy. In all parts of the planet, it can be harnessed and is available every day. Unlike some of the other sources of electricity, we can not run out of solar energy.

As long as we have the sun, solar energy will be abundant, so sunlight will be available to us for at least 5 billion years until, according to scientists, the sun will die.

2. Reduces Electricity Bills

Since the electricity your solar system has generated is going to meet some of your energy needs, your energy bills will decrease. The scale of the solar system and your energy or heat consumption will depend on how much you save on your bill.

In addition, not only can you save on the power bill, but there is also a chance of earning compensation through the Smart Export Guarantee for the surplus energy you export back to the grid (SEG).If you generate more electricity than you use (considering that your solar panel system is connected to the grid).

3. Diverse Applications

For various purposes, solar energy can be used. Electricity (photovoltaics) or heat can be produced (solar thermal). Solar energy can be used to generate electricity in

areas without connection to the energy grid, to distil water in regions with insufficient sources of clean water, and to power space satellites.

In the materials used for homes, solar energy may also be incorporated. Not long ago, transparent solar energy windows were introduced by Sharp.

4. Low Maintenance Costs

Generally, solar energy systems don't need a lot of maintenance. You just need to keep them reasonably clean, so the job will be done by cleaning them a few times a year. You can always rely on specialist cleaning firms, which provide this service from about £ 25-£ 35, if in doubt.

Many reputable solar panel manufacturers give a warranty of 20-25 years.Often there is no wear and tear, since there are no moving pieces. The inverter is typically the only component that needs to be modified after 5-10 years, as it works continuously to turn solar energy into electricity and heat (solar PV vs solar thermal). The cables will need maintenance apart from the inverter to ensure that your solar power system operates at optimum performance.

So you should foresee very little expenditure on maintenance and repair work after paying the initial expense of the solar system.

5. Technology Development

Technology is continually evolving in the solar power industry and developments will accelerate in the future. Innovations in quantum physics and nanotechnology could theoretically improve solar panel efficiency and double, or even triple, the electrical input of solar power systems.

Disadvantages of Solar Energy

1. Cost

There is a very high initial cost of buying a solar system. This involves paying for the installation of solar panels, inverters, batteries, wiring. Nonetheless, there is a continuous evolution of solar technology, so it is fair to say that prices will decline in the future.

2. Weather-Dependent

While it is still possible to capture solar energy on cloudy and rainy days, the solar system's performance decreases. To capture solar energy effectively, solar panels are based on sunlight. A few cloudy, rainy days will, therefore have a noticeable impact on the energy system. You should also take into account that during the night, solar energy can not be gathered.

On the other side, if you still need to work at night or during wintertime with your water heating solution, thermodynamic panels are an alternative to consider.

3. Solar Energy Storage Is Expensive

It is best to use solar energy right away, or it can be stored in big batteries. Used in off-the-grid solar systems, these batteries can be charged during the day so that the electricity is used at night. This is a safe way to use solar energy all day long, but it's also very costly.

Using solar energy during the day and taking energy from the grid during the night is safer in most situations (you can only do this if your system is connected to the grid).Luckily your energy demand is usually higher during the day so you can meet most of it with solar energy.

4. Uses a Lot of Space

Solar energy is better used right away, or it can be stored in large batteries. Used in solar systems that are off-the-grid, these batteries can be charged during the day so that the energy is used at night. This is a safe way for solar energy to be used all day long, but it's also really expensive.

In certain cases, using solar energy during the day and drawing energy from the grid during the night is better (you can only do this if your system is connected to the grid).

5. Associated with Pollution

While there is much less emissions related to solar energy systems compared to other sources of energy, pollution may be associated with solar energy. The release of greenhouse gases has been correlated with the transport and construction of solar systems.

During the production process of solar photovoltaic systems, there are also certain harmful materials and dangerous items used that can indirectly impact the environment.

Nevertheless, solar energy **pollutes far less** than other alternative energy sources.

Reference:

1- https://www.arrow.com/en/research-and-events/articles/5-methods-of-harvesting-solar-energy

2-https://www.slideshare.net/AfrinNirfa1/solar-energy-harvesting-and-its-applications

2- https://www.onio.com/article/what-is-energy-harvesting.html

3- https://www.construction21.org/articles/h/efficiency-of-solar-energy-harvesting.html