Solar Energy is energy generated by the sun. In the most basic sense, it is necessary for life on Earth — but can also be harvested for human uses such as electricity.

The sun is like a nuclear reactor, which releases small energy packets called photons. These photons travel 150 million km to Earth in a little over eight minutes.

According to the US Solar Energy Technologies Office the amount of sunlight that strikes Earth in 90 minutes is enough to provide the world's energy consumption for a full year.

Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation.

Homes or businesses that install solar panels can actually produce excess electricity — which can be sold back to the electric provider, reducing or even eliminating power bills.

The cost of solar energy has dropped dramatically over the last ten years as the industry has scaled up manufacturing and improved the technology with new materials.

EVERYTHING UNDER CONTROL

TRENDS & TALK FOR THE MANUFACTURING INDUSTRY

c3controls is pleased to present another issue in our series of informative articles that provide information on the latest advancements in technology and how they will affect many aspects of our lives moving forward.

Solar energy is light from the sun which is collected using a variety of evolving methods. It has become a widely discussed topic in the development of renewable energy. This powerful and endless source of available solar energy makes it a very promising source of electricity, not only for the environment but financially as well.

Due to increased demand over the past decade, technology involved in solar energy has been continually advancing. As a result, solar energy has turned into a notably efficient resource for clean energy for residential and commercial buildings, as well as industrial manufacturing applications. In the future, we may all reap the many benefits of solar powered electricity in some way.

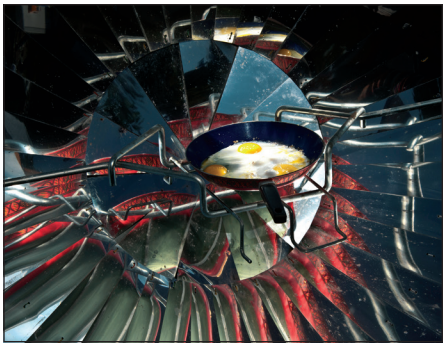
In this article we have provided an overview of Solar Energy — and the ways in which solar energy will impact all of our lives. We have provided information on the latest advancements in the conversion of solar energy into electricity and the applications of that electricity that are available today. We will discuss the upfront costs of turning to solar energy for homes and businesses and what the long term savings and other benefits will be for those that make the change.

How solar power can change our future?

The potential of solar energy to provide the electrical power we need in the future is undeniable. As we harness the sun's clean and free energy, we will greatly reduce our dependence on fossil fuels. Even though solar technology is still in its early stages, it has started to be increasingly cost effective and many people have become aware of the advantages it brings.

Solar energy has become a major topic of discussion worldwide because of the global warming threat. Many scientists agree that by 2030, solar will become the world's most important source of renewable energy. The Solar Energy Industries Association (SEIA) is aiming for solar power to account for 30% of all electricity by 2030 — and 40% by 2035. In addition, the solar industry has already established very clear cost reduction roadmaps, which should see solar costs cut in half by 2030.

We have begun with the growing shift into electric vehicles that can be powered by electricity produced through converting solar energy to electricity. Sound pollution is another major issue that can be found in today's society — and moving toward solar electric powered vehicles will help mitigate sound pollution. We could also help improve our aquatic habitats by eliminating the need for the turbines that are used to generate hydraulic electric energy — instead utilizing solar energy to accomplish that.



The handwriting is on the wall — production of electricity by converting solar energy will be the future of the United States and every other country in the world that depends on electricity for homes, commercial businesses, industrial manufacturing, city lighting needs and more.

What is solar energy?

Solar Energy is energy, which is generated by the sun. It is necessary for life on Earth and can be harvested for human uses such as electricity. Solar energy is created by nuclear fusion that takes place within the sun. Nuclear fusion occurs when protons of hydrogen atoms violently collide in the sun's core and fuse to create a helium atom. This process, known as a PP (proton-proton) chain reaction, emits an enormous amount of energy. The sun fuses about 620 million metric tons of hydrogen every second. This means that the sun is like a nuclear reactor, which releases small energy packets called photons. These photons travel 150 million km to the earth's surface in a little over eight minutes.

Solar technologies convert this sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. The solar energy that is captured and converted can then be turned into usable electricity for homes, commercial buildings, and industrial manufacturing facilities or any other area where electrical power is needed. According to the US Solar Energy Technologies Office the amount of sunlight that strikes the earth's surface in ninety minutes is enough to provide the world's energy consumption for a full year.

Harnessing solar energy

There are several technologies that can harvest solar energy and convert it into electric power for use in homes, businesses, schools and hospitals — virtually anywhere electricity may be needed. Solar energy technologies include photovoltaic cells and panels, concentrated solar energy, and solar architecture. These methods use either active solar energy or passive solar energy.

Active solar technologies use mechanical or electrical devices to actively convert solar energy into another form of energy, most often heat or electricity. **Passive solar technologies** do not use any external devices — instead, they take advantage of the local climate to heat structures during the winter and reflect heat during the summer.

How do solar panels work?

When the sun's photons connect with the solar cells in a panel, the electrons from the atoms are loosened. Each solar cell in a panel contains a semiconductor, usually made of silicon. When the semiconductor absorbs sunlight, it loosens electrons. An electrical field then directs these loose electrons into an electric current. The current flows in one direction and metal contacts coming from the top and bottom of a solar cell direct that current to where electricity is needed.

There are a large number of cells in a solar panel — and a grouping of panels can form a solar array (SA) when wired together. The current can then be directed to something as small as a solar-powered calculator or as large as a power station. The more panels that are used, the more energy that can be generated.

Active solar technology with Photovoltaics

Discovered in 1839 by a 19-year-old French physicist named Alexandre-Edmond Becquerel, photovoltaics is a form of active solar technology that Becquerel discovered when he placed silver chloride in an acidic solution and exposed it to sunlight, the platinum electrodes attached to it generated an electric current. This process of generating electricity directly from solar radiation is called the photovoltaic effect, thus photovoltaics.

Photovoltaics was first used on spacecraft — with many satellites, including the International Space Station, featuring wide, reflective "wings" of solar panels. The ISS has two solar array wings (SAWs), each using about 33,000 solar cells. These photovoltaic cells supply all electricity to the ISS, allowing astronauts to operate the station, live safely in space for months at a time, and conduct numerous scientific and engineering experiments.

Today, photovoltaics (PV) is the most recognized method of harnessing solar energy. Photovoltaic arrays usually involve solar panels — a collection of dozens of solar cells or even hundreds. The cost of PV has dropped dramatically over the last ten years as the industry has scaled up manufacturing and incrementally improved the technology with new materials. Installation costs have come down as well with more experienced and trained installers available. Globally, the U.S. has the third largest market for PV installations and is continuing to rapidly grow.

Most current solar cells are made from crystalline silicon or thin-film semiconductor material. Silicon cells are more efficient at converting sunlight to electricity, but generally have higher manufacturing costs. Thin-film materials typically have lower efficiencies, but can be simpler and less costly to manufacture.

All types of PV systems are widely used in a variety of applications. There are thousands of individual photovoltaic panel models available today from hundreds of companies. A comparison of solar panels should include their efficiency, power output, and warranties.

Photovoltaic power stations have been built all around the world, with the largest stations located in the United States, China and India. Emitting hundreds of megawatts of electricity, these power stations are used to supply homes, schools, hospitals and businesses.

Photovoltaic technology can be used in smaller areas as well. Solar panels and cells can be mounted to exterior walls or in an open area adjacent to the buildings to be supplied with electricity. They can be used to power lighting along roads and highways. Solar cells are also small enough to power smaller devices, such as watches, calculators, flashlights, outdoor residential lighting, parking meters and trash compactors.

Concentrated solar power (CSP)

Another type of active solar technology is concentrated solar energy or concentrated solar power (CSP) — first developed in the 1980s. CSP technology uses lenses and mirrors to focus concentrated sunlight from a large area into a much smaller area. This intense area of radiation heats a fluid, which in turn generates electricity or fuels another process. CSP is a renewable supply that will be a sustainable energy source in helping to reduce the carbon footprint.

The largest facility in the world is a series of plants located in California's Mojave Desert. This Solar Energy Generating System (SEGS) generates more than 650 gigawatt-hours of electricity every year. Similar large power plants have also been built in Spain and India.

- CSP tower power plants are each comprised of a tall tower supporting a heat receiver surrounded by a field of heliostats — flat mirrors that turn to follow the sun's arc through the sky and focus its rays onto the receiver. The heliostats are each fitted with a solar tracking system so that they can track the sun across the sky. These power plants can achieve a higher concentration ratio that allows the collector to reach a higher working temperature with minimal thermal loss.

- CSP solar cookers are used on a smaller scale — and can be used by people in villages throughout the world that have no access to electricity. The use of solar cookers to boil water for sanitation and to cook food can improve the lives of many people.

Solar cookers provide many advantages over wood-burning stoves — there is no fire hazard, no smoke and no fuel required. Using a solar cooker reduces habitat loss in forests where trees are harvested for fuel. Solar cookers are currently used in many remote areas of the world.

- CSP parabolic dish systems use mirrors that are mounted over a parabolic-shaped dish to focus the sun's rays onto a receiver. The receiver is positioned at the focal point on a nearby structure along with a heat engine, which has thin tubes inside it. The tubes contain a gas, such as helium or hydrogen, or even air. The system, which can attain very high temperatures, is equipped with a tracking system that follows the arc of the sun.

- CSP parabolic trough is a type of solar thermal collector that is straight in one dimension, curved as a parabola in the other two, and lined with a polished metal mirror. With a parabolic trough system solar energy is concentrated by the curved, trough-shaped polished metal reflectors, which are focused onto a receiver pipe. The pipe usually contains thermal oil, which is heated and then used in the thermal power block to generate electricity in a steam generator.

- CSP fresnel reflectors use flat, thin strips of mirror to capture sunlight and direct the concentrated rays onto a tube of thermal liquid. The liquid then goes through a heat exchanger to power a steam generator. Fresnel reflectors have more surface area than parabolic troughs and can concentrate the sun's energy to about 30 times its normal intensity. This technology is much cheaper to install but has lower efficiency.

Passive solar architecture

During the course of a day, solar energy is part of the process of thermal convection — or the movement of heat from a warmer space to a cooler one. As the sun rises, it begins to warm objects and materials on Earth. Throughout the day, these materials absorb heat from solar radiation. At night, when the sun sets and the atmosphere cools, the materials release their heat back into the atmosphere. Passive solar energy techniques take advantage of this natural heating and cooling process.

Homes and other buildings use passive solar energy to distribute heat efficiently and inexpensively. Calculating a building's "thermal mass" is an example of this. A building's thermal mass is the bulk of materials heated throughout the day. Examples of a building's thermal mass are wood, metal, concrete, clay, stone or mud. At night, the thermal mass releases its heat back into the room. Effective ventilation systems, including hallways, windows and air ducts distribute the warmed air and maintain a moderate, consistent indoor temperature.

Passive solar technology is often involved in the design of a building. For example, in the planning stage of construction, the designer or architect may align the building with the sun's daily path to receive desirable amounts of sunlight. This method considers the latitude, altitude and typical cloud cover of a specific area. In addition, buildings can be constructed or retrofitted to have thermal insulation, increased thermal mass, or add extra exterior shading.

As passive solar technology has evolved, other types of structures have proven to be effective in cutting the energy required to cool buildings. Obviously, these developments have proven to be critically important in warmer climates, as energy requirements for cooling outpace the need for heat.

Cool roofs

Cool roofs are painted white and reflect the sun's radiation instead of absorbing it. The white surface reduces the amount of heat that reaches the interior of the building, which in turn reduces the amount of energy that is needed to cool the building.

Green roofs

Green roofs are completely covered with vegetation — requiring soil and irrigation to support the plants, with a waterproof layer beneath. Green roofs not only reduce the amount of heat that is absorbed or lost, but also provide vegetation. Through photosynthesis, the plants on green roofs absorb carbon dioxide and emit oxygen. They also filter pollutants out of rainwater and air, offsetting some of the effects of energy use in that building.

Green roofs and cool roofs can also counteract the "urban heat island" effect. In busy cities, the temperature can be consistently higher than the surrounding areas. Many factors contribute to this including the materials used to construct cities such as asphalt and concrete that absorb heat. In addition, tall buildings block wind and its cooling effects — and businesses, traffic and dense population generates a high amount of heat. Using the available space on the roof to plant trees, or reflecting heat with white roofs, can partially alleviate local temperature increases in urban areas.

Radiant barriers

Similar to cool roofs, radiant barriers provide insulation covered with a highly reflective material, such as aluminum foil facing the heat source. Instead of absorbing the heat, the foil reflects it and can reduce cooling costs up to 10%. In addition to roofs and attics, radiant barriers may also be installed beneath floors.

Solar Energy helping to cool and heat

Since sunlight only shines for about half of the day in most parts of the world, solar energy technologies have to include methods of storing the energy during dark hours. As previously discussed, a building's thermal mass is heated throughout the day — then at night, the thermal mass releases its heat back into the room. Photovoltaic systems can send excess electricity to the local power grid or store the energy in rechargeable batteries.

These storage technologies have increased the viability of increasing the country's reliance on solar energy — but there are still pros and cons to address as we work toward this end.

Advantages

- A major advantage to using solar energy is that it is a renewable resource. We will have a steady, limitless supply of sunlight for another 5 billion years.
- No fuel is needed — meaning the solar technology equipment runs clean. No emitting of greenhouse gases or toxic materials. Using solar energy can drastically reduce our impact on the environment and save money.
- There are practical locations where solar energy is an attractive option. Homes and buildings in areas with high amounts of sunlight and low cloud cover have the opportunity to harness the sun's abundant energy.
- Solar cookers provide an excellent alternative to cooking with wood-fired stoves for 2 billion people. Solar cookers provide a cleaner and safer way to sanitize water and cook food.
- Solar energy is a great addition to the list of other renewable energy sources such as wind or hydroelectric energy.
- Homes or businesses that install solar panels can actually produce excess electricity. These homeowners or businessowners can sell energy back to the electric provider, reducing or even eliminating power bills.

Disadvantages

- Although solar technology equipment costs have dropped over the last decade, it is still expensive. Currently the average cost of purchasing and installing the equipment is nearly $20,000 for individual homes and even more for businesses depending upon the size of the installation.
- Despite eliminating electricity bills — and the government often offering reduced taxes to people and businesses using solar energy — the initial cost is still too steep for many to consider.
- Solar energy equipment is extremely heavy. In order to retrofit or install solar panels on the roof of a building, the roof must be strong, large, and oriented toward the sun's path — which often means high remodeling costs.
- Both active and passive solar technology depend on abundant and consistent sunlight. Local areas must be studied to determine whether or not solar power would be effective in that area.

Electrical machine controls for over four decades

We hope you have benefited from this issue of *EVERYTHING UNDER CONTROL* and that this information helps you to understand what changes and benefits Solar Power will bring to the future. There will be opportunities for c3 and many companies to play a major role in helping our nation to adapt to the creation of electricity using solar power and other renewable clean energy sources.

In future issues, we will present information on the latest trends and advancements for a wide variety of industries that depend on c3controls products as an integral part of their machine controls.

Handling Customer Concerns

Quality at c3controls includes our comprehensive follow-up service after the sale. In order to respond promptly to customers, c3controls has a quality process in place which includes immediate return and replacement of the product to keep our customers' production up and running — as well as a comprehensive review of the product application to determine if the perceived issue is only present under certain conditions.

The goal of the quality process is to identify what specific issues the customer is experiencing with the product — including determining problems that are application specific and to prevent those issues from reoccurring in the future.

Advantage Pricing

We have complete control over our engineering and manufacturing processes, maintain lower overhead costs than our competitors, and offer our factory-direct business model. We offer customers a buying partnership that can save them up to 40% — and has helped our customers improve profitability and cash flow for more than 44 years.

Same-Day Shipping

At c3controls, we know how important it is to get your orders on time, every time. That's why we offer Guaranteed Same-Day Shipping on any order for standard catalog items received by 6:00pm ET. Our customers enjoy peace of mind knowing they will get what they need, when they need it. A promise that we know can help you reduce inventory and save money.

Limited Lifetime Warranty

While other companies claim to offer the highest quality products on the market, at c3controls we guarantee it. We can ensure high quality because we have total control over every aspect of the engineering and manufacturing processes.

Quality that meets your exact requirements

Using our decades of experience, c3controls continues to expand our culture of 'quality' to design products that meet our customers' challenges of today and tomorrow.

c3controls produces durable, well-designed electrical control products that meet global standards for quality and safety — and perform reliably even in the most punishing environments. Ranging from power and actuation to control logic to human machine interface to wiring/cable duct — c3controls offers products that perform the essential control functions that are at the heart of nearly every electrically operated machine and equipment.

For further details on our world-class products, call us today at 724.775.7926 or visit us at www.c3controls.com