Solar Field
Photovoltaic Array
Solar array

Basic Description:
The photovoltaic array captures energy from the sun and converts it into energy, using the photoelectric effect, which can be utilized for electricity needs of the Center.

Components:
Photovoltaic cells are connected to make modules. Modules are connected to make arrays. The system also requires inverters and meters.

Site Specifics:

- *864 individual Yingli solar modules*
- *100kW Satcon Inverter*
- *50kW Satcon Inverter*
- *Total Capacity: 151kW (DC) system*
- *Contractor: Borrego Solar Systems, Inc.*
- *Ground mounted fixed system*
- *Grid connected or Utility interactive*

How it works: When photons or miniscule particles of energy from the sun are absorbed by the system, an electron is knocked loose creating an electrical current. Only certain wavelengths of sunlight work efficiently to create energy. Once the electrical current has been created, the energy is in a form called DC (Direct Current). In order for the energy to be utilized by the building and in the utility grid, it must first be converted into AC (Alternating Current) which is done in an inverter. Once the energy has run through the inverter it can then be utilized in the building.

Net metering: The system on-site is a grid connected or utility interactive system. All energy generated on the site is utilized to fulfill the site's energy needs first. If at any point the system generates a greater amount of energy than is needed, the extra energy is then fed into the public utility grid to be utilized by the utility company (Southern California Edison). For any energy that is fed back into the grid, credit is provided on the energy bill. This is monitored through a net metering system. This meter also works in the reverse. If at any point the site requires more energy than the system generates, energy can be provided from the public utility grid. The site **DOES NOT** have the ability to store energy generated for use at a later time.

System efficiency: The photovoltaic system generates approximately 50% of the energy consumed by the site. The estimated value of the energy generated from installation to December 2014 is approximately $165,000.

Incentives: There are a variety of federal and state incentives that are provided for individuals and businesses that install photovoltaic systems. Sunnylands Center & Gardens participated in two of these incentive programs. The first is the California Solar Initiative (CSI) which is a performance-based incentive that provides for monthly compensation (at a set rate) for each kilowatt hour (kWh) of energy generated by the system. The second was the Savings by Design program that provides nonresidential new construction projects incentives for the energy efficiency of their designs.

Problems/Warning: While there are obvious benefits to the use of solar power, there are some things that should be carefully considered when one is contemplating installing a photovoltaic array. Expectations should be realistic. Once the system is online, it does not mean that you will never pay another energy bill again. The system will have variances in generation based on weather conditions and will decrease in efficiency every year. Every system requires maintenance; PV arrays are similar to your car. They have certain routine maintenance that needs to be done consistently to ensure that the system is working effectively and at its peak efficiency. There is no one-size-fits-all system. Careful consideration should be given to each site individually and the type and size of the system that would work best for its needs. Be cautious of modeling estimations. Some of the modeling provided will not take into consideration all of the systems on a site that are consuming energy and often times they are heavy consumers such as humidifiers. Do your own research before you install a system so that you can ask the appropriate questions and are aware of all of the benefits and pitfalls of the installation of a photovoltaic array

Resources:

US Department of Energy (energy.gov)
Exploringgreentechnology.com
Southern California Edison (SCE.com)
Go Solar California (gosolarcalifornia.ca.gov)
Savings by Design (savingsbydesign.com)
DSIRE: Database of State Incentives for Renewable Energy (dsireusa.org)
Physics.org (physics.org)
Einstein Year 2005 (einsteinyear.org)
Rosenbaum, Marc. *Understanding the Energy Modeling Process: Simulation Literacy 101,* http://www.buildinggreen.com/features/mr/sim_lit_101.cfm

Glossary:

Photoelectric Effect: When photons of energy hit the solar cells, it gives its energy to electrons allowing them to be knocked loose from the atom and move around. The movement of electrons generates an electrical current. “The photons could be compared to the white ball in a game of pool, which passes on its energy to the coloured balls it strikes. (physics.org)”

Module: photovoltaic cells or solar cells that are electrically connected to each other and mounted in a support frame or structure. Multiple modules can be connected together to create an array. (Commonly referred to as solar panel)

Array: a systematic arrangement of something in rows or columns; in this case solar panels in rows that are all interconnected.

Inverter: When the solar array creates energy, it creates it in a form called DC or (Direct Current). This is not a form of energy that can be utilized by the grid or by the buildings on site so an inverter is needed to convert the energy generated into AC (Alternating Current) which is the form of energy that you use in your house every day.

Meters: a device that measures the amount of energy consumed by site. The meters are read periodically either through site visits or remotely (with digital smart meters) and then based on the amount of energy used, usually in the units of kilowatt-hours (kWh), a site is billed for energy. The meter that is used for the Center & Gardens is a bi-directional meter that will keep track of the energy generated on-site and feed back into the public utility grid as well as the amount of energy pulled off the public grid and used.

Modeling: computer-based tools that are used to simulate energy use of an un-built project. When properly done, modeling can help to guide design teams to optimize the building design through strategies that will have the greatest effect on the building energy use. There are many unknowns that must be estimated about the building design and operational use for modeling. The accuracy of these inputs will determine the accuracy of the modeling predictions. While modeling is a great tool for guiding design, it is important to remember that actual operational use and environmental factors all come into play for the actual energy use of the building and therefore actual energy consumption will often differ from the modeling estimations.