

## Sustainability September: Solar Array

Explore the science behind solar panels and our use of solar energy here at Duke Farms.

The sun has been a source of light and warmth all throughout human history. Perhaps the earliest use of solar power was in the 7th Century BCE when the Ancient Greeks figured out how light fires by focusing sunlight with pieces of magnifying glass.

The scientific search for a technology to harness the sun's rays began way back in the 1700s, but it wasn't until 1954 that Daryl Chapin, Calvin Fuller, and Gerald Pearson of Bell Labs created the first silicon photovoltaic (PV) cell. They are credited with the invention of PV technology because their design was the first to capture solar energy and use it to power a small toy Ferris wheel and a radio transmitter for many hours. Today, photovoltaic cells, *photo* meaning light and *voltaic* meaning electricity, are the solar devices that capture the energy of the sun and convert it to electricity. A solar array consists of multiple PV solar cells working together to replace conventional means of energy production. No fossil fuels are used in the process; hence no carbon or pollutants are spewed into the air. As long as the sun continues to shine, it is an unlimited and renewable energy source.



Solar array at Duke Farms



The solar array at Duke Farms is a 640-kilowatt ground-mounted system that covers 2.6 acres. It is made up of 3,120 solar panels that generates 250.35kWh per year, enough electricity to power 76 homes! The array saves nearly 800,000 kw per year and prevents 700 tons of carbon from polluting atmosphere. The system is tied to the local electric grid so when solar panels generate more energy than is needed, the additional power is sent to the public power grid. On cloudy days or at night, when the solar panels are not producing enough energy, Duke Farms draws power from the grid.

The solar panels are arranged so they are in perfect orientation to “solar south” which, in New Jersey, is about thirteen degrees west of compass south. They are tilted at twenty-five degrees. The orientation to the sun and the tilt of the panels is critical in optimizing the efficiency of how these solar panels collect the sun's rays and convert it into energy. The panels are strategically positioned 17 feet apart so that on the shortest day of the year, at noon, the arrays don't shade one another. The electricity generated by these panels is captured as direct current. To use this in the buildings and recharging stations for electric vehicles at Duke Farms, this current goes through a solar inverter, which converts it to alternating current. This electricity can then be transmitted over long distances through electric lines. \*

The goal at Duke Farms is to pave a way forward for humanity in the battle against climate change through electrifying everything. Our cars, appliances, homes, schools, corporate parks, factories, hospitals, farms, airports... anything you can think of can be powered by renewable energy sources. It's the only way we will be able to meet our planet's energy needs for a sustainable future.

\*Adapted from the Guide to Duke [Farms](#)

### Fun in the Sun Activities:

#### Make a solar-powered oven

One of the coolest hot projects you can make at home is a solar oven. You will be making an oven that will actually cook food by concentrating heat from the sun in a pizza box.

Thermal energy or heat from the sun will be absorbed by your solar oven and transferred to your food and it will get cooked! There are lots of solar oven designs available on the internet, but this one is very doable (as long as you can get a pizza box!)

Check out how to make a sun powered oven [here](#) and go outside and try it!

*Warning: Never cook meat in a solar oven!*



#### Make sun prints

A fun nature craft you can do at home is a sun print. When sunlight shines on light-sensitive paper, it will change the color of the paper. Any object placed on top of the paper will leave a shadow or silhouette of the object that was sitting on top. For this activity you can purchase sun sensitive art paper from a craft store or use construction paper to make your art project. Then go out on a nature walk and find some leaves, shells or pebbles to make imprints on your paper. Watch a video and find instructions for making a sun print craft with sun sensitive paper [here](#). Or watch how to do it with construction paper [here](#). This is a wonderful project to combine the joy of a nature experience with art.

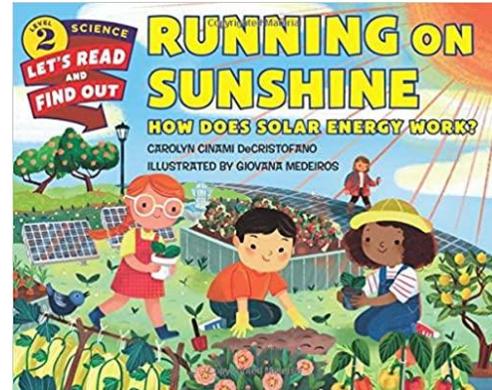


#### Additional Resources

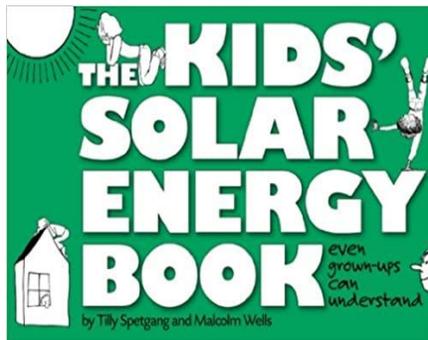
- [History of Solar Energy](#)
- [Timeline of Solar Power Development](#)
- [NJ DEP Solar Power](#)
- [All About Solar Energy](#)
- [Sustainable Jersey Solar Resources](#)

### To extend or partner your learning...

An oldie but goodie, the Let's Read and Find Out Series has been an AAAS, American Association for the Advancement of Science, Award winner and has been authored by astronomers, teachers and science writers and visiting experts such as Dr Bart Bartlett, Chemistry Professor from the University of Michigan. Since its inception, the series has served as an introduction for children to a wide range of scientific subjects, combining read aloud narrative with appealing illustrations



As stated on the cover, this is a book about solar energy ...that even grown-ups can understand.

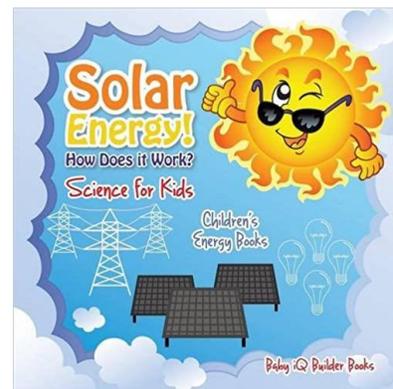


Using appealing cartoons The Kids Solar Energy Book, demonstrates how solar power works in a clear and understandable way. The fun lesson unfolds in a classroom where students explore solar energy and today's technology: active systems, passive solar, and the conversion of sunlight into electricity. There are simple and clear lessons on the need for solar power in this our environmentally challenged world.

This book might be useful for younger learners as it introduces solar energy as a renewable resource that can power homes, vehicles and businesses. It shows in simple terms how the sun's energy can be converted and used in the community.

An interesting **STEM Resource** to consider...

The University of Colorado -Boulder, has numerous lesson plans and activities in their [Teach Engineering](#) series. Using Sun Lab, participants make portable sundials, learn how to calculate "local noon", and more. Worksheets and sample assessment tools are provided in areas of STEM along with "Questions for Investigations" such as:



- How does the sun appear to move across the sky?
- Does the sun change its path through the sky from month to month?
- Why is it important for us to have an instrument to mark time?
- Why is "true north" important for the accuracy of a sundial?
- What is the difference between "real time" and "clock time"?



## **Learning about the Duke Farms solar array aligns with the newly adopted NJ Student Learning Standards. Adopted 2020 New Jersey Student Learning Standards (NJSLS)**

### **Climate Change**

New Jersey is the first state in the country to require climate change curriculum across all content areas and at a K-12 level. As stated by the NJDOE:

On June 3, 2020, the State Board of Education adopted the 2020 NJSLS in the following content areas:

- Career Readiness, Life Literacies, and Key Skills;
- Comprehensive Health and Physical Education;
- Computer Science & Design Thinking;
- Science;
- Social Studies;
- Visual and Performing Arts;
- and World Languages.

These standards truly represent a foundation from which districts will build coherent curriculum and instruction that prepares each New Jersey student with the knowledge and skills to succeed in our rapidly changing world. They will put New Jersey again at the forefront of national education by including the following:

- Climate Change across all content areas, leveraging the passion students have shown for this critical issue and providing them opportunities to develop a deep understanding of the science behind the changes and to explore the solutions our world desperately needs.

### **Technology, Engineering, Design and Computational Thinking**

The Duke Farms resources found on the Distance Learning Portal can be integrated to reach these NJ Learning Standards. <https://www.dukefarms.org/making-an-impact/distance-learning/>

[New Jersey's Technology Standards](#) consist of 8.1 Educational Technology and 8.2 Technology, Engineering, Design and Computational Thinking, which work symbiotically to provide students with the necessary skills for college and career readiness.

"Advances in technology have drastically changed the way we interact with the world and each other. The digital age requires that we understand and are able to harness the power of technology to live and learn". - International Society for Technology in Education

In this ever-changing digital world where citizenship is being re-imagined, our students must be able to harness the power of technology to live, solve problems and learn in college, on the job and throughout their lives. Enabled with digital and civic citizenship skills, students are empowered to be responsible members of today's diverse global society.

**For more information about how you may use New Jersey's Technology Standards and the topic of solar energy to address the teaching of climate change in your PK-12 and beyond classrooms, contact Kate Reilly, Manager of Education, Duke Farms at [kreilly@dukefarms.org](mailto:kreilly@dukefarms.org)**