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George E. Pataki, Governor

New York State
Energy Research and Development Authority

Vincent A. Delorio, Esq., Chairman

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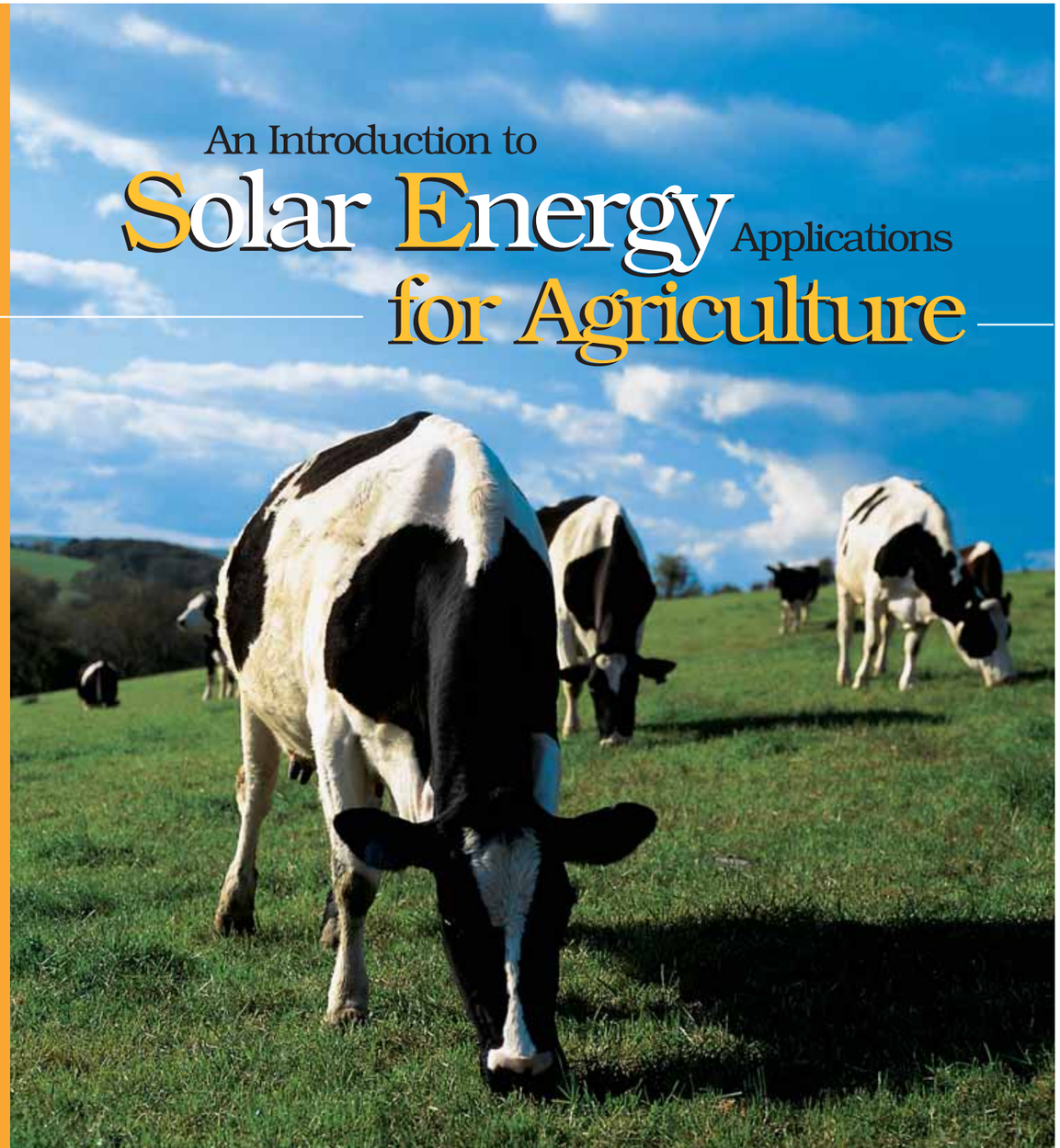
NYSERDA

Solar Power ...Naturally

An Introduction to Solar Energy Applications for Agriculture



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Farming, particularly dairy farming, can be a very energy-intensive industry. Fortunately, solar energy can supply and supplement many farm energy requirements. The following is a brief overview of some applications of solar energy technologies used in agriculture. Additional sources are provided for more specific information about the solar energy applications highlighted in this guide. The New York State Energy Research and Development Authority (NYSERDA) has incentives and programs for some solar electric applications. (www.PowerNaturally.org)

Contents

This document was prepared using information provided by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy Consumer Energy Information EREC reference briefs (www.eere.energy.gov/consumerinfo/refbriefs/da1.html)

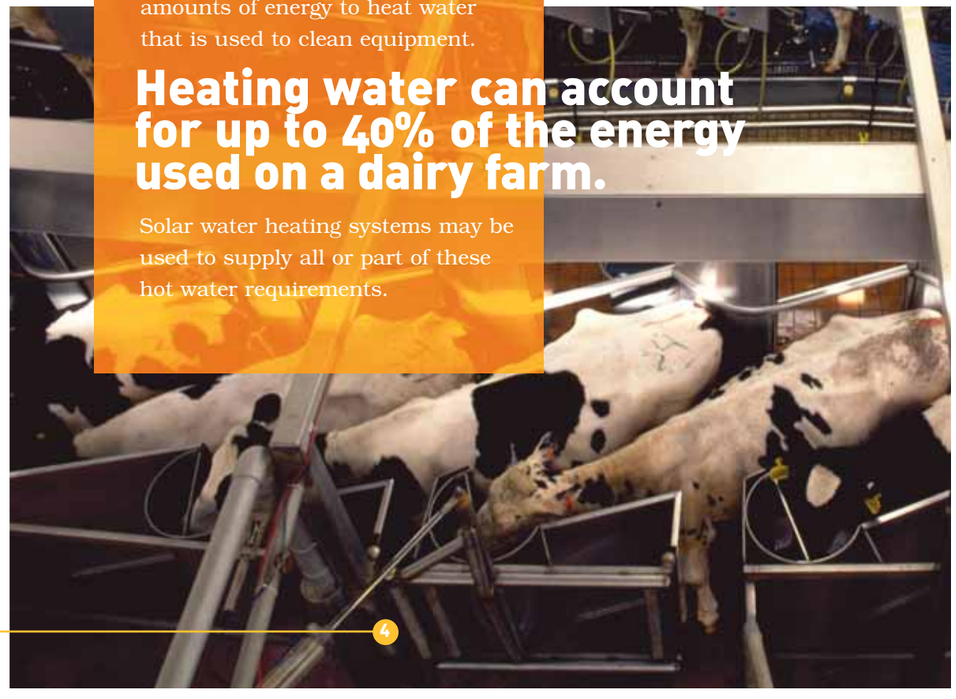
LIVESTOCK AND DAIRY OPERATIONS OFTEN HAVE SUBSTANTIAL AIR AND WATER HEATING REQUIREMENTS.

Many pig and poultry farms raise animals in enclosed buildings to control temperature and air quality in an effort to maintain animal health and growth. These facilities need to replace the indoor air regularly to remove moisture, toxic gases, odors, and dust. **Heating this air, when necessary, requires large amounts of energy.** With proper planning and design, solar air heaters can be incorporated into farm buildings to preheat incoming fresh air. These systems can also be used to supplement natural ventilation levels during summer months. **Solar water heating systems can provide hot water** for pen or equipment cleaning or for preheating water going into a conventional water heater. Visit www.nrel.gov/clean_energy/farmer_solarwater.html and www.eere.energy.gov/RE/solar_hotwater.html for more information on solar water heating and www.agcom.perdue.edu/AgCom/pubs/AE/AE-99.html for solar heating systems.

Commercial dairy farms use large amounts of energy to heat water that is used to clean equipment.

Heating water can account for up to 40% of the energy used on a dairy farm.

Solar water heating systems may be used to supply all or part of these hot water requirements.



SOLAR APPLICATIONS

Using the sun to dry crops and grain is one of the oldest and most widely used applications of solar energy. The simplest and least expensive technique is to allow crops to dry naturally in the field, or to spread grain and fruit out in the sun after harvesting. The disadvantage of these methods is that the crops and grain are subject to damage by birds, rodents, wind, and rain, and contamination by windblown dust and dirt. **More sophisticated solar dryers can protect grain and fruit, reduce losses, dry faster and more uniformly, and produce a better quality product than open-air methods.**

The basic components of a solar dryer are an enclosure or shed, screened drying trays or racks, and a solar collector. The southern side of the enclosure itself can be glazed to allow sunlight to dry the material. The collector can be as simple as a glazed box with a dark-colored interior to absorb the solar energy that heats air. The air heated in the solar collector moves up through the material being dried—either by natural convection or forced by a fan. The size of the collector, and rate of airflow needed, depend on the amount of material being dried, the moisture content of the material, the humidity in the air, and the average amount of solar radiation available during the drying season.

There are relatively few large solar crop dryers in the United States. This is because the cost of the solar collector can be high, and drying rates are not as controllable as they are with natural gas or propane powered dryers. **Designing the collector for other uses at other times of the year, such as for heating farm buildings, may make a solar dryer more cost-effective.**

For more information on solar crop drying, visit: www.fsec.ucf.edu and www.oit.doe.gov/combustion/factsheets/freshway.pdf

Greenhouse Heating

ANOTHER AGRICULTURAL APPLICATION OF SOLAR ENERGY IS GREENHOUSE HEATING.

Commercial greenhouses typically rely on the sun to supply their lighting needs, but they are not designed to use the sun for heating. Instead, they rely on gas or oil heaters to maintain the temperatures necessary to grow plants in the colder months. Solar greenhouses, however, are designed to utilize solar energy for both heating and lighting.

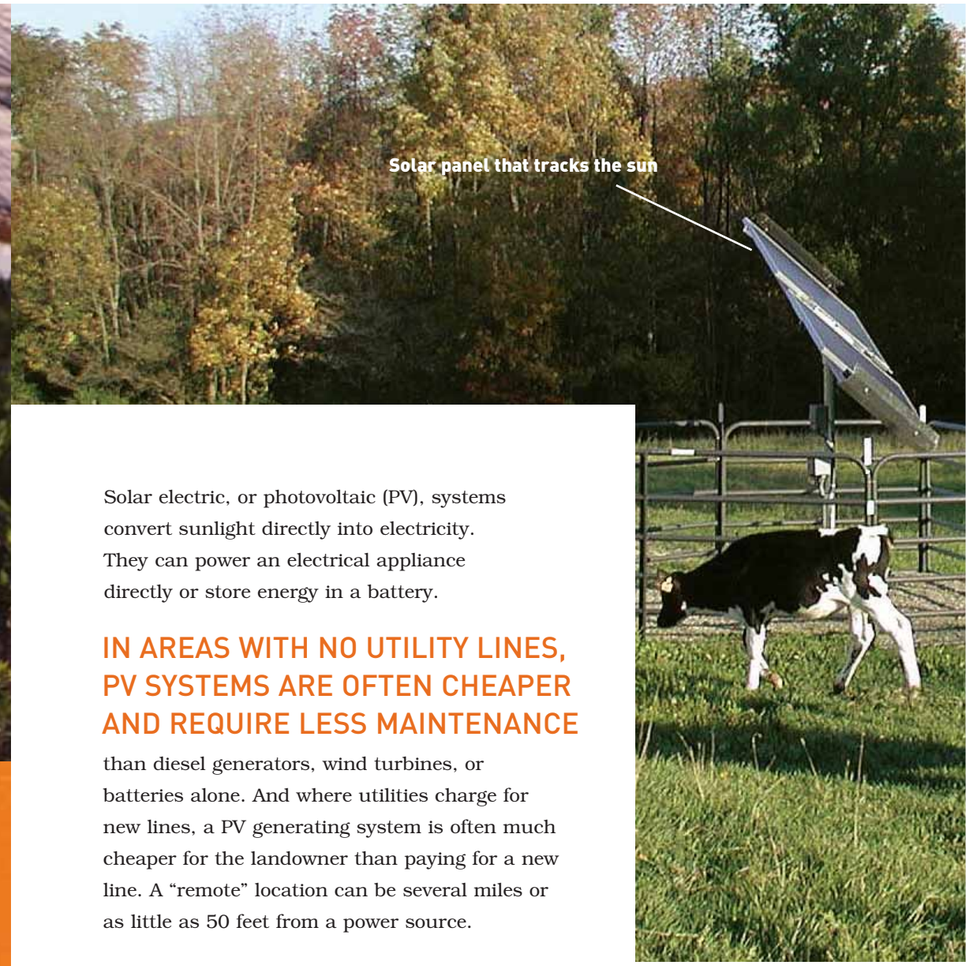
A solar greenhouse has thermal mass to collect and store solar heat energy and insulation to retain this heat for use during the night and on cloudy days. A solar greenhouse is oriented to maximize southern glazing exposure. Its northern side has little or no glazing and is well insulated. To reduce heat loss, the glazing itself is also more efficient than single-pane glass; various products are available ranging from double-pane to "cellular" glazing.

A solar greenhouse reduces the need for fossil fuels for heating.

A gas or oil heater may serve as a back-up heater, or to increase carbon dioxide levels to induce higher plant growth.

For further information on Solar Greenhouses visit:
www.eere.energy.gov/consumerinfo/factsheets/vg9.html
or http://attra.ncat.org/attra-pub/solar-gh.html

Solar Electric (Photovoltaic) Systems



Solar electric, or photovoltaic (PV), systems convert sunlight directly into electricity. They can power an electrical appliance directly or store energy in a battery.

IN AREAS WITH NO UTILITY LINES, PV SYSTEMS ARE OFTEN CHEAPER AND REQUIRE LESS MAINTENANCE

than diesel generators, wind turbines, or batteries alone. And where utilities charge for new lines, a PV generating system is often much cheaper for the landowner than paying for a new line. A "remote" location can be several miles or as little as 50 feet from a power source.

PV SYSTEMS ARE VERY RELIABLE, AND THEY PRODUCE POWER IN ALL TYPES OF WEATHER.

On partly cloudy days, they can produce up to 80 percent of their potential energy. Even on extremely overcast days, they may still produce about 25 percent of their maximum output. Weather damage is no greater problem for PV systems than for other structures in rural areas. Designers test panels for hail impact, high wind, and freeze-thaw cycles representing year-round weather conditions.

PACKAGED PV SYSTEMS OR KITS ARE NOT DIFFICULT TO INSTALL.

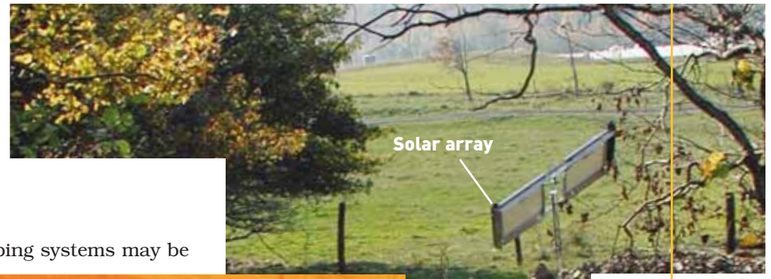
Manufacturers provide literature and telephone support for do-it-yourselfers. And for systems with more complicated components, such as tracking mounts and inverters to convert direct current (DC) to alternating current (AC), professional installation and service is often included in the purchase price. Visit www.PowerNaturally.org for a list of PV installers participating in NYSERDA's programs. NABCEP.org has a list of nationally certified PV installers.

Most PV modules now come with 20-25 year warranties.

Because PV systems have no moving parts, maintenance is limited to visual checks and servicing batteries. Suppliers may offer maintenance agreements for larger systems that have tracking mounts and energy-conversion equipment.

PV SYSTEMS ARE VERY SAFE.

The voltage from a single PV module is usually low and not hazardous. Systems with several modules and batteries must include overload protection and fuses to meet local electrical codes. NYSERDA has programs to assist with the installation of grid-connected PV systems. For more information check out "A Detailed Guide to Installing a Solar Electric System" at www.PowerNaturally.org or call us at 1-866-NYSERDA and request the guide. Be sure to also visit www.nrel.gov/clean_energy/farmer_pv.html



WATER PUMPING

Photovoltaic (PV) water pumping systems may be

the most cost-effective water pumping option

in locations where there is no existing power line. They are exceptionally well-suited for grazing operations to supply water to remote pastures. Simple PV power systems run pumps directly when the sun is shining, so they work hardest in the hot summer months when they are needed most. Generally, batteries are not necessary because the water is stored in tanks or pumped to fields and used in the daytime. Larger pumping systems may include batteries, inverters, and tracking mounts to follow the sun.

When properly sized and installed, PV water pumps are very reliable and require little maintenance. The size and cost of a PV water pumping system depends on the quality of solar energy available at the site, the pumping depth, the water demand, and system purchase and installation costs. There are several companies that manufacture systems designed for pumping water from wells, ponds, or streams. Although today's prices for PV panels make most crop irrigation systems too expensive, PV systems are very cost-effective for remote livestock water supply, pond aeration, and small irrigation systems. For example, a system that includes a 128 watt PV array and a submersible pump can produce 750-1000 gallons of water per day from a 200 foot drilled well. The equipment costs about $3000. Installation costs are additional.

For animal grazing operations, PV powered pumps can offer the most economical and lowest maintenance option to supply water in remote pastures. Pumps and controllers specifically designed for PV have been used in the western United States for years and are also proven to work in New York for seasonal use. For more information on PV water pumping, visit: http://attra.ncat.org/attra-pub/pdf/solarlswater.pdf or www.usda.gov and search for "solar water pumping."

LIGHTING

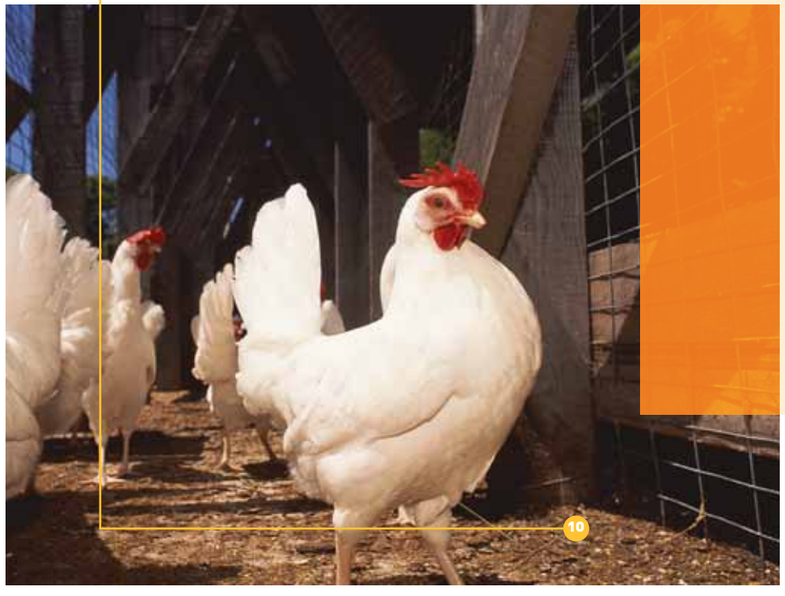
Even when utility power is available nearby, using PV to charge batteries for lighting may be the cheapest option for outbuildings. The cost of a transformer and running wires to where the light is needed can add up. A simple PV system can operate low- or high-pressure sodium lights, as well as fluorescent and incandescent bulbs.

SMALL MOTORS

Electric motors with small power needs can be very handy in remote areas or in places where running an electrical line is a problem. PV-powered automatic gate openers use a 14" by 13" PV panel to charge the battery. PV is also used to run aeration fans in grain storage bins and to power automatic supplement feeders.

VENTILATION

Certain agriculture enterprises such as chicken and turkey farms must have constant ventilation during the hot summer months. **The body heat from thousands of birds in close proximity to each other can quickly kill them if electricity is lost.** Since it operates when the sun makes the air the warmest, PV can be an ideal power source in this instance. It has extremely high value, since one episode of grid power loss, where the PV takes over and saves the birds, could pay for a large part of the system immediately. Since animal losses will be avoided, insurance companies may be willing to reduce premiums, thereby helping to pay for the system. PV powered ventilation can also help relieve peak power requirements on the grid, and makes use of direct current (DC) motors rather than conversion to alternating current (AC) which requires a costly inverter.



Additional Information

The following websites are good sources of information about solar energy and solar energy for agriculture.

NEW YORK STATE SOLAR ENERGY INDUSTRY ASSOCIATION*
www.nyseia.org

SOLAR ELECTRIC POWER ASSOCIATION*
www.solarelectricpower.org

SOLAR ENERGY INDUSTRY ASSOCIATION*
www.seia.org

THE SOURCE FOR RENEWABLE ENERGY
ONLINE SOLAR BUYER'S GUIDE AND BUSINESS DIRECTORY*
www.energy.sourceguides.com

NORTH AMERICAN BOARD OF CERTIFIED ENERGY PRACTITIONERS*
www.nabcep.org

AMERICAN SOLAR ENERGY SOCIETY (ASES)
www.ases.org

FLORIDA SOLAR ENERGY CENTER
www.fsec.ucf.edu

INTERSTATE RENEWABLE ENERGY COUNCIL
www.irecusa.org

MILLION SOLAR ROOFS
www.millionsolarroofs.com

NATIONAL RENEWABLE ENERGY LABORATORY
www.nrel.gov/solar

CENTER FOR RENEWABLE ENERGY AND SUSTAINABLE TECHNOLOGY
www.crest.org

U.S. DEPARTMENT OF ENERGY
ENERGY EFFICIENCY AND RENEWABLE ENERGY
www.eren.doe.gov

NORTH CAROLINA SOLAR CENTER
www.ncsc.ncsu.edu

APPROPRIATE TECHNOLOGY TRANSFER FOR RURAL AREAS
www.attra.ncat.org

U.S. DEPARTMENT OF AGRICULTURE
www.usda.gov

For more information about NYSERDA solar electric energy programs,
call 1-866-NYSERDA
or visit www.PowerNaturally.org

*websites providing lists or links to equipment manufacturers, distributor, or installation and service providers