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SOLAR ENERGY APPLICATIONS FOR AGRICULTURE

Chikaire, J. Nnadi, F.N., Nwakwasi, R.N., Anyoha, N.O, Aja O.O., Onoh, P.A., and Nwachukwu C.A.
Department of Agricultural Extension
Federal University of Technology, Owerri
Email: bankausta@ yahoo.com

ABSTRACT

Renewable energy and farming are a winning combination. Wind, solar and biomass energy can be harvested forever, providing farmers with a long-term source of income. Renewable energy can be used on the farm to replace other fuels or even sold as a cash crop. It is one of the most promising and important opportunities for value-added products in agriculture. It has been said that "anything that can be generated from a barrel of oil can be generated from biomass. They type of renewable energy technology used in agriculture depends on the type of energy required, access to the renewable energy source and the design of agricultural facilities and processes. Solar energy can be used in agriculture in a number of ways, saving money, increasing self-reliance, and reducing pollution. Solar energy can cut a farm's electricity and heating bills. Solar heat collectors can be used to dry crops and warm homes, livestock buildings, and greenhouses. Solar water heaters can provide hot water for diary operations, pen cleaning, and homes. Photovoltaics (solar electric panels) can power farm operations and remote water pumps, light, and electric fences. Building and barns can be renovated to capture natural day light, instead of using electric light, solar power is often less expensive than extensive power lines, making the farm more economical and efficient. This paper therefore discusses briefly the various applications of solar energy technologies in agriculture.

Keywords: Agriculture, photovoltaic, renewable energy, solar.

INTRODUCTION

Renewable energy-such as solar, wind, and biofuels can play a key role in creating a clean, reliable energy future. The benefits are many and varied, including a cleaner environment. Electricity is often produced by burning fossil fuels such as oil, coal, and natural gas. The combustion of these fuels releases a variety of pollutants into the atmosphere, such as carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen oxide (NO_2), which create acid rain and smog. Carbon dioxide from burning fossil fuels is a significant component of greenhouse gas emissions. These emissions could significantly alter the world's environment and contribute to global warming (Svejkovsky, 2006).

Renewable energy, on the other hand can be a clean energy resource. Using renewables to replace conventional fossil fuels can prevent the release of pollutants into the atmosphere and help combat global warming. For example, using solar energy to supply a million homes with energy would reduce Co_2 emissions by 4.3 million tons per year, the equivalent of removing 850,000 cars from the road (Svejkovsky, 2006). Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (natural replenished). In 2006, about 18% of global fuel energy consumption came from renewables, with 13% coming from traditional biomass, which is mainly used for heating, and 3% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, bio-fuels) accounted for another 2.4% and are growing very rapidly. The share of renewables in electricity generators is around 18%, with 15% of global electricity coming from hydroelectricity and 3.4% from new renewable (Wikipedia, 2009). This paper thus outlines some applications of solar energy technologies used in agriculture.

AGRICULTURAL APPLICATIONS OF SOLAR ENERGY

Solar energy can supply and or supplement many farm energy requirements. The following is a brief discussion of a few applications of solar energy technologies in agriculture.

CROP AND GRAIN DRYING

Using the sun to dry crops and grain is one of the oldest and mostly widely used applications of solar energy. The simplest and least expensive techniques 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 grains are subject to damage by birds, rodents, wind, and rain, and contamination by wind blown dust and dirt. More sophisticated solar dryers protect grain and fruit, reduce losses, dry faster and more uniformly, and produce a better quality product than open air methods (EREC, 2002; UCS, 2009).

The basic components of a solar dryer are an enclosure or shed, screened drying trays or racks, and a solar collector. In hot, arid climates, the collector may not even be necessary. 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 coloured interior to absorb the solar energy that heats air. The air heated in the solar collector moves, either by natural convection or forced by a fan, up through the material being dried. The size of the collector and rate of airflow depends 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 (Schepens, 1986).

There is a relatively small number of large solar crop dryers around the world. 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.
Using the collector at other times of the year, such as for heating farm building, may make a solar dryer more cost effective. It is possible to make small, very low cost dryers out of simple materials. These systems can be useful for drying vegetables and fruit for home use (NYSERDA, 2009).

SPACE AND WATER HEATING

Livestock and diary operations often have substantial air and water heating requirements. Modern pig and poultry farms raise animals in enclosed buildings, where it is necessary to carefully control temperature and air quality to maximize the health and growth of the animals. These facilities need to replace the indoor air regularly to remove moisture, toxic gases odors, and dust. Heating this air, when necessary, requires large amount of energy. With proper planning and design solar air/space 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 depending on the region and weather. Solar water heating can provide hot water for pen or equipment cleaning or for preheating water going into a conventional water heater (Goedseels, 1986; WFE, 2002). Water heating can account for as much as 25 percent of a typical family's energy costs and up to 40 percent of the energy used in a typical dairy operation. A properly-sized solar water-heating system could cut those costs in half (Garg, 1987; UCS, 2009).

There are four basic types of solar water-heater systems available. These systems share three similarities: a glazing (typically glass) over a dark surface to gather solar heat; one or two tanks to store hot water; and associated plumbing with or without pumps to circulate the heat-transfer fluid from the tank to the collectors and back again (Schnepf, 2005; Schnepf, 2007; Svejkovsky, 2006).

(a) Drain down systems pump water from the hot water tank through the solar collector, where it is heated by the sun and returned to the tank. Valves automatically drain the system when sensors detect freezing temperatures.
(b) Drain back systems use a separate plumbing line filled with fluid, to gather the sun's heat. These systems operate strictly on gravity. When the temperature is near freezing, the pump shuts off and the transfer fluid drains back into the solar storage tank.
(c) Anti-freeze closed-loop systems rely on an antifreeze solution to operate through cold and winter months. Anti-freeze solutions are separated from household water by a double-walled heat exchange.
(d) Bread box batch systems are passive systems in which the storage tank also functions as the collector. One or two water tanks, painted black, are placed in a well-insulated box or other enclosure that has a south wall made of clear plastic or glass and titled at the proper angle. This allows the sun to shine directly on the tank and heat a batch of water. An insulated cover can provide freeze protection (Svejkovsty, 2006).

GREENHOUSE HEATING

Another agricultural application of solar energy is greenhouse heating. Commercial green house typically rely on the sun to supply their lighting needs, but are not designed to use the sun for heating. They rely on gas or oil heaters to maintain the temperatures necessary to grow plants in the colder months. Solar greenhouse, however are designed to utilize solar energy both for 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 (EREC, 2002). A solar green house 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, and 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 (NYSERDA, 2009).

Passive solar greenhouses are often good choices for small growers, because they are a cost-efficient way for farmers to extend the growing season. In colder climates or in areas with long periods of cloudy weather, solar heating may need to be supplemented with a gas or electric heating system to protect plants against extreme cold. Active solar greenhouses use supplemental energy to move solar heated air or water from storage or collection areas to other regions of the greenhouse (Svejkovsky, 2006).

REMOTE ELECTRICITY SUPPLY (PHOTOVOLTAIC)

Solar electric, or photovoltaic (PV), systems convert sun light directly to electricity. They work any time the sun is shining, but more electricity is produced when they sun light is more intensive and strikes the PV modules directly (as when rays of sunlight are perpendicular to the PV modules). They can also power an electrical appliance directly, or store solar 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 land owner than paying for a new line (NYSERDA, 2008; EREC, 2009).

PV allows for the production of electricity–without noise or air pollution-from a clean, renewable resource. A PV system never runs out of fuel. Solar electric power comes in very handy on farm and ranches, and is often the most cost-effective and low-maintenance solution at locations far from the nearest utility line. PV can be used to power lighting, electric fencing, small motors, aeration fans, gate-openers, irrigation valve switches, automatic supplement feeders. Solar electric energy can be used to move sprinkler irrigation systems (Svejkovsky, 2006). PV systems are also extremely well-suited for pumping water for livestock in remote pasture, where electricity from power lines is unavailable. PV is often much less-expensive than the alternative of extending power lines into these remote areas.

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 day time. Larger pumping systems may include batteries, inverters, and tracking mounts to follow the sun (EREC, 2002; NYSERDA, 2009).

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, 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 200 foot drilled well (EREC, 2002).

CONCLUSION

Agricultural technology is changing rapidly. Farm machinery, farm buildings and production facilities are constantly being improved. Cheaper and improved sources of energy are needed for efficient and smooth operations of the facilities. These sources of energy are clean, risk-free and constitute no harm to man and environment.

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