APPLICATION OF SOLAR ENERGY IN AGRICULTURE AND INDUSTRY

By

A. B. C. Nzekwe
Department of Science Laboratory Technology,
Federal Polytechnic,
Oko.

and

F. N. Nzekwe
Department of Science Laboratory Technology,
Federal Polytechnic,
Oko.

Abstract

Solar energy can supply and/or supplement many farm and industrial energy requirements. The applications of solar energy in the agricultural sector are enormous which includes areas like crop and grain drying, space and water heating, greenhouse heating, water pumping etc. Hence this application will greatly improve the agricultural potentials of Nigeria. This research also reviews the industrial applications of solar energy which may be useful for development and economical purposes. Improved system efficiencies and reduced capital costs are identified as goals in the operation of solar energy industrial projects.

Energy is part and parcel of life. *Solar energy—power from the sun—is clean and unlimited. Capturing the sun's energy for light, heat, hot water, and electricity can be a convenient way to save money. Whether drying crops, heating buildings, or powering a water pump, using the sun can make the farm more efficient.* The amount of energy from the sun that reaches Earth each day is enormous. All the energy stored in Earth's reserves of coal, oil, and natural gas is equal to the energy in just 20 days of sunshine *(Li, 2007)*. Plants make direct use of the sun's rays, of solar energy, to produce the materials they need to grow. Without the sun life on our planet would not be possible. And, without plants there would be no food for man or beast. The sun supplies rain and sunshine, warmth and cold, directly. Solar energy can be used in agriculture in a

number of ways thereby saving money, increasing self-reliance, and reducing pollution. One of the simplest ways to use solar energy is to design or renovate buildings and barns to use natural daylight instead of electric lights. Dairy operations using “long day “ lightning to increase production can save money with skylights and other sun-lighting options (www.caddet-re.org*)*.

The sun's heat can also be used to warm homes and livestock buildings. In confinement operations, a steady supply of fresh air is critical to maintaining animal health, but this can result in substantial heating bills. "Active" solar heating systems, which use heat boxes and fans, can warm the air, saving on fuel. "Passive" solar designs, where the building is designed to take advantage of the sun automatically, are often the most cost-effective approach. Solar water heaters can provide low- to medium-temperature hot water for pen cleaning. Dairy operations can use solar heated water to clean equipment and to warm and stimulate cows' udders. For homes or farms with electric or propane water heaters, solar collectors can save hundreds of dollars per year (Hamdam and Jubran,1992).

Solar energy is available in abundant amount on earth and shifting our electricity requirements on solar energy is most likely to be the option in coming future. Solar applications are available in sectors like residential, commercial, industry and agriculture. But emphasis is laid only on agriculture and industry. Improved system efficiencies and reduced capital costs are identified as goals in the operation of solar energy industrial projects (Mathur and Khanna, 1957).

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 (Avinash, Matt and Isaac 2008).

Crop and Grain Drying: Using the sun to dry crops and grains 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 grains are subject to damage by birds, rodents, wind, and rain, and contamination by windblown 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 (Avinash, Matt and Isaac, 2008).

Space and Water Heating: Livestock and dairy 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 amounts 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 induce or increase natural ventilation levels during summer months. Solar water heating systems can provide low to medium temperature hot water for pen cleaning. Commercial dairy farms use large amounts of energy to heat water to clean equipment, as well as to warm and stimulate cows' udders. Heating water and cooling milk 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 (Kalogirou, 2006).

Greenhouse Heating: Another agricultural application of solar energy is greenhouse heating. Commercial greenhouses 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 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-panel glass, and various products are available ranging from double panel 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 (Avinash, Matt and Isaac, 2008).

Water Pumping: When properly sized and installed, Photovoltaic (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 makes most crop irrigation systems too expensive, PV systems are very cost-effective for remote livestock water supply, pond aeration, and small irrigation systems. 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 (Fawwaz and Isam, 1993).

Lighting Small Motors: Even when utility power is available nearby, using PV panels 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. 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 panel is also used to run aeration fans in grain storage bins and to power automatic supplement feeders.

Certain agricultural 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 panel 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 (Agricultural Applications of Solar Energy, 2002; www.nyserda.org/programs/pdfs/agguide.pdf).

Industrial Applications of Solar Energy

Solar energy has been in use in industry and provides multiple industrial applications, especially when power is required in remote locations. Solar power can be useful in such industrial applications where small kilowatt energy is required. Some examples of remote location solar powered applications are TV Station, Radio broadcasting towers, repeater stations, radio telephones etc. Solar power also facilitates electricity in transportation signaling system. There are cities which are totally equipped with solar powered traffic signal systems and does not require conventional electricity to operate. Other transportation systems include navigation systems, light houses in oceans, runway lights on airports, security camera in dark etc. Other industrial applications where solar power is used are environmental, situation equipment and protection systems for well heads, bridges, pipelines etc. Such applications where electricity load is high, solar power can prove cost effective by configured hybrid electric power systems that join photovoltaic solar power system with small generators that operate on fuel or natural gas. Solar power is highly reliable and can work on locations where conventional electricity is not reachable. Space is one of the examples for it. Satellites are powered by solar power from the day when first satellite was launched in space. Solar car is another most sophisticated application of solar energy. Photovoltaic cell is installed on the surface of the car which converts sun light into electricity to power up a car (Avinash, Matt and Isaac, 2008).

Typical Applications and Most Promising Sectors of Industry

Cleaning is a process that occurs in many forms. Cleaning of bottles, cans, kegs and process equipment is the most energy consuming part in food industry, also metal treatment plants (galvanizing, anodizing, painting,..) have cleaning processes of parts and surfaces. Textile industry and laundries clean fabrics and service stations clean cars. All of them need warm water at temperatures below 100°C and even below 60°C very often. They provide an excellent application for solar thermal energy. Storage and its integration into the existing heat supply system is rather easy in these cases since storage tanks exist very often and water is the main medium (Mathur and Khanna, 1957).

Drying is also very energy intensive. Most of the washing processes require subsequent drying. Although the drying medium will be warm air in general, it will be heated up through water/air –heat exchangers. Preheating with solar heat might be a viable option in that case. Evaporation seen from the viewpoint of thermodynamics is not very different to drying: the more volatile component has to change phase through the input of energy.

Application can be found in food industry and chemistry mainly. Pasteurisation and sterilisation need heat of 75 or 105°C respectively. In food industry and biochemistry there are numerous applications. With liquids, pasteurisation can be performed in heat exchangers, for solids (cans, bottles,); there is a need for a heat transfer medium like water, air or steam.

Preheating boiler feed water is another possible application for solar heat in the process industry. Since this is a low temperature heat sink, solar energy is suited very well, but there might be other heat sources available in the process at cheaper conditions. Heating of production halls will be necessary in many countries in wintertime. Although heating is not purely an industrial application, there might be special challenges due to the fact, that the heat supply system might be the same for processes and space heating.
Solar cooling with absorption systems is a very special application of solar heat in industry. Integrated into the whole energy system of the industrial plant it might offer special chances in some branches like the food industry. Cogeneration with gas turbines, steam turbines and/or diesel motors provides low temperature heat at reasonable prices as well. More than this, new technological developments can shift the energy demand from heat to power and will change the future demands (Carrilho da Graca, Andrade and Boucinha, 2004).

Conclusion

Agricultural and industrial technologies are changing rapidly. Farm machinery, farm buildings, and production facilities are constantly being improved. One should consider these factors when purchasing and installing a solar system. Payback periods may be shortened by the multiple use of a solar system, such as for space heating and crop drying. Photovoltaic (PV) technology, can offer a variety of practical alternative energy solutions for Nigeria.

Recommendation

There are many reasons why it is important to adopt some kind of alternative source of power generation before we run out of current sources which produce electricity for us. Solar energy is available in abundant amount on earth and shifting our electricity requirements to solar energy is most likely to be the option in the coming future.

References

Agricultural Applications of Solar Energy (2002). www.eere.energy,gov/ Consumerinfo/....EREC.

Application of Solar Energy in Agriculture and Industry. www.nyserda.org/programs /pdfs/agguide.pdf.

Avinash, G.; Matt, H. & Isaac, M. (2008). Solar Energy. http://en.wikipedia.org/wiki/solar-energy

Carrilho da Graça, G.; Andrade, L. & Boucinha, M. (2004). *Solar Heat for Industrial processes-Task 33/IV*. www.solarpaces.org

Fawwaz, E. & Isam, M. (1993). *Energy Policy*. Vol. 21, Issue 9.

Hamdam, M.A. & Jubran, B.A. (1992). *Renewable Energy*. Vol. 2, Issue 3.

Kalogirou, S.(2006). *The Potential of Solar Energy in Food Industry*. www.pdfcast.org/…/thepotential-of-solar-energy-in-food-industry-process-heat-applications.

Li Z.S, (2007). *Application and Development of Solar Energy in Building Industry*. www.linkinghub.elsevier.com/retrieve/pii/so301421507000493.

Mathur, K.N. & Khanna, M.L. (1957). *Application of Solar Energy to Small Scale Industries.* New Delhi: Grolier Publisher.

Up with the Sun. Solar Energy and Agriculture. (1996) www.caddet-re.org.