Bethel College Mennonite Church Creation Care Committee

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Title: Can Solar Electric Panels Provide Electrical Energy at a Reasonable Cost and Reduce Greenhouse Gas Emissions?

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Introduction

Solar Photovoltaic Systems are being installed at an increasing rate in the US and other countries. This increase is related to the:

1. Reduced costs of photovoltaic installations relative to the amount of energy supplied.
2. Simplicity of installation of new systems with no moving parts and little maintenance.
3. The environmental benefits from a clean energy source which doesn't produce green house gas emissions.
4. Net Metering laws permit connecting to the power grid for storage of excess power and use later when needed at the regular rates.
5. Tax incentives that are helping to make systems more economically/financially feasible.
6. The need to replace traditional energy sources which are limited in supply and often being imported from other countries with locally produced renewable clean energy.

What is a Photovoltaic system?

A system consists of:

1. Solar electric panels (PV panels) that generate direct current (DC) electrical power and energy.
2. A storage system such as batteries or grid connection to store the energy.
3. An Inverter to convert the DC voltage to alternating current (AC) for homes or businesses.

How do Photovoltaic Systems Work?

Solar Panels produce electrical power. The basic idea of a solar panel is that sunlight falls on a photocell typically made of a silicon metal wafer and through the process of the photoelectric effect creates a voltage and current output. Each cell typically puts out approximately one half volt. Connecting 60 cells together can provide an operating voltage of 30 volts DC for a panel. Typical cells can generate up to 8 amperes of current at noon which, when multiplied times the voltage power output, equals 240 watts DC. Multiple panels can provide increased electrical power output.

Electrical Energy is Stored Either in Batteries or on the Power Grid

Historically batteries were used to store the energy from the panels to provided energy when the sun is not shining. This still is an option in remote areas or where backup energy is needed. Batteries, however, are expensive, require maintenance, and are not environmentally friendly. Hence, not the best option for storing electrical generated energy if a power grid connection is available.

If electrical power is available through a commercial electrical company, a better storage option is to connect the solar system to the power grid which is called a Grid Tie PV System. During the day solar-produced electricity reduces what is being used from the electric company and, if excess power is produced, it will go into the power grid. At night the electric company will return the created energy from the grid. Homeowners must work with their electrical companies to get approval to install a system.

Inverters Convert the Direct Current output of Solar Panels to Household Alternating Current

There are two types of inverters which are designed to connect to provide electricity to a home and put power back into the grid. One option is a central inverter that connects to all the panels. The other option is to use a micro-inverter on each individual panel. The micro-inverters optimize each panel individually and the central inverter tries to optimize a whole string of collectors such as 10 to 14 in a circuit. If one panel in the string is not working because of shading or a problem with a panel this tends to shut down the string similar to what happens in Christmas tree lights.

Electrical Consumption of a Typical Single Family Residence

The electrical consumption of a typical family depends whether it is an all electric home or a home that also is connected to gas or other heating sources. The air conditioning load is another factor. A very efficient low energy home with other sources of heat energy might use 4,000 KWH of electricity per year. A more typical home would use 6,000 to 12,000 KWH. An all electric home could use 12,000 to 20,000 KWH or more depending on size and location. My personal residence is an all-electric home and uses approximately 12,500 KWH per year.

System Costs

If one wants to produce 4000 KWH/Yr for a home in Kansas then the PV power would need to be 2,600 watt of solar panels or approximately 11 solar panels with a total area of 200 square feet. The installed cost would be in the order of $15,000. A Do-It-Yourselfer could install the system for possibly $10,000. These costs estimates would be before savings from tax credits or electric company rebates.

Federal and State Tax Credits

The US federal government law currently provides a tax credit of 30% on the installed costs of a PV system. A $15,000 solar system would receive a $4,500 of tax credit reducing the costs to $10,500. For a Do-It-Yourself installation, the cost would be reduced from $10,000 to $7,000. In 25 years at 4,000 KWH/Yr the system would generate 100,000 KWH and the cost per KWH would be 7 cents/ KWH. The current electric rates in Kansas are approximate 10 cents/KWH in many cities including Newton, and up to 20 cent/KWH in rural areas. Kansas doesn't have any state tax credits, however, many states do. For example, Arizona has a $1,000 state tax credit.

Power Company Rebates

Many power companies provide rebates to the installer in the order of $1.50 to $3.00/watt. Kansas City Power and Light recently approved $2.00 per watt rebate for Missouri customers. An owner installing a 2600 watt PV system receives a one time rebate of $5,200 from the power company.

Economic Viability of Solar PV Systems

Combining Federal Tax Credits, State Tax Credits, and Power Company rebates can significantly reduce the cost of a PV system. The savings on the electric bill combined with increased property values adds to the economic viability of installing a PV system. Conservation should also be part of the solar planning and a careful analysis of a home's energy use could save 20 percent or more and reduce the size of the PV solar system needed. Pay back periods in Kansas range around 15 years with current credits and rebates. The system will continue producing electricity for many years after that. (For more details on costs, call or visit Nelson Kilmer at Hesston College.)

Green House Gas (GHG) Emissions Reductions

One of the major benefits of installing a PV system is the reduction of the amount of carbon dioxide going into the atmosphere. Most of the electricity in KS is provided by coal-fired power plants. To create a KWH of electricity the US average is 2.1 pounds CO_2/KWH from coal fired plants. A solar system that would produce 4,000 KWH per year would save 8,400 pounds of CO_2 from going into the atmosphere annually. Electricity generation is the largest producer of GHG in the US (exceeds all transportation).

Creation Care Opportunity

The opportunity exists in Kansas and other states to install Solar PV systems that are economically viable and can significantly reduce the emissions of CO_2 GHG into the atmosphere. Grid Tie Solar PV systems are a cost effective reliable approach to using a renewable energy source. Tax credits and power company rebates are stimulating a solar PV industry which is growing at a significant rate. It is fun to see a credit on an electric bill for excess energy generated in a month. An opportunity exists for us to be part of helping Kansas meet its goal of 20 % of the electricity generated from renewable energy by 2020 and to also be a good steward of our global environment.