ACTIVE SOLAR ENERGY TECHNOLOGIES - EXISTING AND NEW DEVELOPMENT

The simplest and most direct application of solar energy is the direct conversion of sunlight into low-temperature heat (up to a temperature of 212 degrees F). In general, two classes of technologies can be distinguished: passive and active solar energy conversion. Passive solar design refers to the use of the sun's energy for the heating, cooling and day-lighting of living spaces. In this approach, the building itself or some element of it takes advantage of the natural energy characteristics in materials and air created by exposure to the sun. Passive systems are simple, have few moving parts, no mechanical systems, and require minimal maintenance. In contrast, active solar energy technologies require the transport of heat through a medium and thus need components to transform and transfer the solar energy.

Active solar energy technologies reduce a building's fossil fuel energy requirements and associated fuel costs. Energy from active solar sources has two major applications or uses for homes and buildings. One is as a source of **electricity**, and two is as source of **heat** for household hot water and space heating. Simple collectors, usually placed on the roof of a house or building, absorb the sun's energy and then transfer the heat to a media that moves it to points of usage. In many climates, a solar heating system can provide a high percentage (50 to 75%) of domestic hot water energy. Since, on average, water heating accounts for around 15% to 25%, or more, of the energy use of a home and 30% of its CO_2 emissions, a solar water heater can reduce residential total emissions by more than 20%. The US National Renewable Energy Laboratory calculates the current technical potential of solar water heating in the U.S. at 1 Quad (a Quad is a unit of energy equal to 10^{15} BTU) of primary energy savings per year, equivalent to an annual CO_2 emission reduction of about 50 to 75 million metric tons. Solar energy is therefore an obvious choice for a carbon-smart, reliable energy future.

Given the prospects of solar energy, communities can position themselves to take greatest advantage of their own local energy resources. In this way, communities can encourage the creation of local jobs based on solar and other renewable technologies while reducing their overall carbon footprint.

The real estate market value of solar homes, whether newly constructed or retrofitted, will thus be relatively higher than the conventional homes.

APPLICABLE NEW JERSEY GOALS AND TARGETS

Reduce projected energy use by 20% by 2020 and meet 20% of the State's electricity needs with Class 1 renewable energy sources by 2020 (NJ Energy Master Plan).

Stabilize GHG emissions at 1990 levels by 2020/ Reduce emissions to 80% below 2006 levels by 2050 (E.O. 54; NJ Global Warming Response Act, P.L.2007, c.112).

SUGGESTED ACTIONS AND STRATEGIES

There are several technology applications for the use of active solar energy in homes and buildings:

Low-temperature solar applications

The easiest and most direct application of solar energy is the direct conversion of sunlight into low-temperature heat. With active solar conversion, there is always a solar collector, and the heat is transported to the building's point of usage by a medium using a conventional energy source. (In contrast, passive solar technologies convert sunlight into usable heat, cause air-movement for ventilation or cooling, or store heat for future use, without the assistance of other energy sources. See Fact Sheet on Passive Solar Design - New Development also included in this technical guide series).

Solar Domestic Hot Water (SDHW) Systems

These systems consist of three components: a solar collector panel, a storage tank, and a circulation system to transfer the heat from the panel to the tank. SDHW systems for households range in size and technology type depending on hot water demands and climate conditions. Pump (or active) circulation systems are generally used in climate zones with a serious frost and overheating danger. They can involve either direct heating of circulating tank water, or, more commonly, use of a heat-absorbing (low-freezing point) fluid that circulates through the collectors and then heats the water tank (via a heat exchanger). Passive systems that rely on natural convection also exist. Almost all collectors installed are of the "flat plate" type. SDHW systems are commonly produced from metals (aluminum, copper, steel), glass and insulation materials; all metals and glass can be recycled. The energy payback time of a SDHW system is now generally less than one year.

Solar Space Heating

Another building sector technology, a solar space system can be sized for single houses or for collective buildings and *district heating* (i.e., using a central collector area). Space heating systems are available as (a) water systems and (b) as air heating systems, with the latter generally cheaper. Water-based systems are usually combination systems that supply domestic hot water and space heating.

Both passive and active water heating systems must follow the same parameters for installations - south facing unshaded location with the collector tilted at the angle of our latitude.

Photovoltaic (PV) solar energy

Photovoltaic (PV) solar energy systems involve the direct conversion of sunlight into electricity by flat plates and concentrators. To make use of the electricity from photovoltaic cells and modules, one has to build a complete system, also comprising electronic parts, support structures, and sometimes electricity storage. The essential component of these systems is the *solar cell*, in which the "photovoltaic effect" - the generation of free electrons using the energy of light particles - takes place. These electrons are used to generate electricity.

Solar Homes

The use of PV systems in homes can be as stand alone systems with battery storage. Typical sizes are from 50 watts to 1 kilowatt. Since PV modules offer an intermittent source of energy, battery storage units (usually a lead-acid battery) are required to provide energy during the night or during days with insufficient sunshine. In some cases, batteries store energy during longer periods.

Grid-Connected Rooftop Systems

PV systems can also be grid-connected and their typical sizes range from 500 watts to 5 kilowatts. The solar cells may be mounted on rooftops or on the ground. The grid serves as "virtual storage." Excess electricity produced (above what the household or business consumes) is fed into the grid. The State provides a *net metering* incentive which allows PV system owners/users, among others, to be credited by utilities for electricity they feed to the grid.

STATE TECHNICAL/FINANCIAL ASSISTANCE

The NJ Clean Energy Program has an existing Customer On-Site Renewable Energy Rebates (CORE) program. Consumer incentives are available to residential customers. The costs of installation, equipment, and interconnection are paid incrementally based on the size of the system. See www.njcep.com/html/2_incent.html. (However, please note that the BPU's queue for funding is extremely long due to high levels of program popularity.)

Residential and small commercial customers installing grid-connected solar technologies are offered net metering under the state's Electric Discount and Energy Competition Act (EDECA) up to 2 MW capacity. Utilities credit the customer at the full retail rate for each kilowatt-hour produced by a Class I renewable energy system installed on the customers' side, up to the total amount used by that customer during an annualized period. Beyond that amount, utilities pay wholesale. Customers may also apply to the Board of Public Utilities (BPU) to participate in NJ's Solar Renewable Energy Certificates (S-RECS) program, which provides a means for solar certificates to be created and verified and allows the certificates to be sold to electric suppliers to meet their solar Renewable Energy Portfolio Standards (RPS) requirement.

FURTHER INFORMATION

Solar Energy Basics - www.nrel.gov/learning/re_solar.html

Photovoltaic Primer - www.buildingscienceconsulting.com/resources/misc/BSC_PV_Primer.pdf

Solar Water Heaters - www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12850

Solar Water Heating - www.energystar.gov/ia/new_homes/features/ESSolarWaterHeating.pdf

Solar Space Heating — "The Complete Handbook of Solar Air Heating Systems"
www.builditsolar.com/Projects/SpaceHeating/SolAirHtSysBook/SolAirHtingBk.htm

Liquid-based Active Solar Heating
www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12500

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