

### Small Commercial Solar Thermal Systems

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#### Overview

Two sample solar thermal projects designed, engineered and installed by Southern Energy Management

##### ***Retirement Community – Triangle region, NC***

With over 400 residents, a Triangle-based retirement community recently decided to reduce their energy use and address climate change by investing in a 6-collector solar thermal system for their cafeteria, which serves all meals to their residents. The solar thermal system provides 20% of the cafeteria's hot water needs, insulates the community from rising natural gas fuel costs, and takes an important first step to reduce the community's carbon footprint.

##### ***Biofuel Manufacturing Facility – Pittsboro, NC***

A major biofuel manufacturing facility recently built a one-million-gallon-per-year biofuel production facility in Pittsboro, and decided to outfit it with a 12-collector solar thermal system. The solar system was designed and built to be expandable so the company could increase their solar capacity as it became feasible. The solar thermal system now has the capability to pre-heat for an industrial water tank or the biodiesel reaction tank, and to pre-heat a 12,000-gallon biodiesel storage tank in the winter. The system will supply clean, renewable energy, provide protection against future price volatility, and reduce the company's environmental impact.

#### Applications and Uses

Small-scale commercial solar thermal systems are developed for a building's main hot water consumption needs, for facilities such as cafeterias, restaurants, veterinary offices, community centers, health clubs and laundromats. Commercial solar thermal projects are usually set up as pre-heat applications for the building's existing water heating system or hot water loop.

Solar thermal systems can also be used for heating pools. In general these installations are less expensive- because no storage is required- and they offer a similar return on investment.

#### Installation Costs

Small-scale systems typically contain 4 - 15 collectors. Because daily water usage fluctuates throughout the day and seasonally, engineers do not design solar thermal systems to meet 100% of total or maximum hot water demand. The estimated installation costs for small commercial projects typically are in the range of \$3,500 – 4,000 per collector; a 6-collector system for a restaurant would cost about \$21,000 - \$24,000 at today's market prices.

Similar to large commercial projects, one of the biggest factors affecting cost is the type of roof at the building site. If the collectors can be mounted flat to a composite shingle (residential type) roof, the cost is lower. For flat commercial roofs, the collectors must be installed on commercial mechanical equipment curbs, requiring additional materials and labor.

The height of a commercial structure also impacts the cost. Taller buildings, more than two stories, may require additional pumps to circulate fluid, extra piping, the use of a crane to lift materials to the roof and additional labor. For drain-back systems, this means larger drain back modules to hold additional fluid.

## Tax Benefits and Investment Return

While energy savings, monthly utility savings and long-term value of a solar system are important, the attractive financial payback on solar thermal is primarily driven by state and federal tax incentives, which include tax credits and accelerated depreciation. The current incentives allow the owner of a system to recover approximately 70% of the cost of the system over the first five years. Assuming the owner has the tax liability to fully utilize these incentives, solar thermal projects have a 5 to 6 year payback in North Carolina. Optimum water usage patterns or utility incentive programs and federal grants can decrease the payback to 4 to 5 years. For more information on solar tax incentives see [www.dsireusa.org](http://www.dsireusa.org).

## Energy and Cost Savings

Energy produced and used can be estimated based on demand, amount of storage and the efficiency of the building's primary water heating system. Energy savings can then be projected using current utility rates and a realistic projected rate of increase in utility prices (called an escalation rate).

Example: 6-collector	Electric	Natural Gas
System cost	\$21,350	\$21,350
Utility rate	\$.085/kWh	\$1.35/therm
Efficiency of existing system*	90%	60%
Solar energy produced	18,464 kWh/yr	630 therms
Actual energy saved (solar energy / efficiency of system):	20,516 kWh/yr	1,050 therms
Total \$ savings (year 1):	\$1,744	\$1,418
Net tax benefits:	\$14,945	\$14,945
Payback:**	Year 4	Year 4

\* based on ACEEE data- <http://www.aceee.org/consumerguide/waterheating.htm>

\*\*using a 5% utility escalation rate for electricity and a 9% rate for natural gas

## Energy Produced

A 4' x 10' solar thermal collector (total aperture of 40 ft<sup>2</sup>) will produce 8-11 MMBTU (million BTUs) per year\*. However, consumption patterns and amount of storage can impact how much of this energy can be used. Solar panels produce the most energy from 10 a.m. to 4 p.m. The energy produced is stored in a commercial hot water tank until it is needed. While water is the best thermal storage medium, an average size commercial tank (120 gal) will lose one degree in average temperature for every hour it is not provided BTUs. A qualified solar installer will take all of these variables into account when designing financial models and properly sizing and designing a system to meet hot water usage patterns for optimum performance.

\*based on the rating of the Alternate Energy Technology AE-40 collector (certification #100-2002-001F) by the Solar Rating Certification Council ([www.solar-rating.org](http://www.solar-rating.org)), adjusted for North Carolina meteorological data (<http://www.cpc.ncep.noaa.gov>).

## Project Feasibility Variables

### Use of hot water:

- Ideal project has predictable, regular hot water consumption

### Roof type:

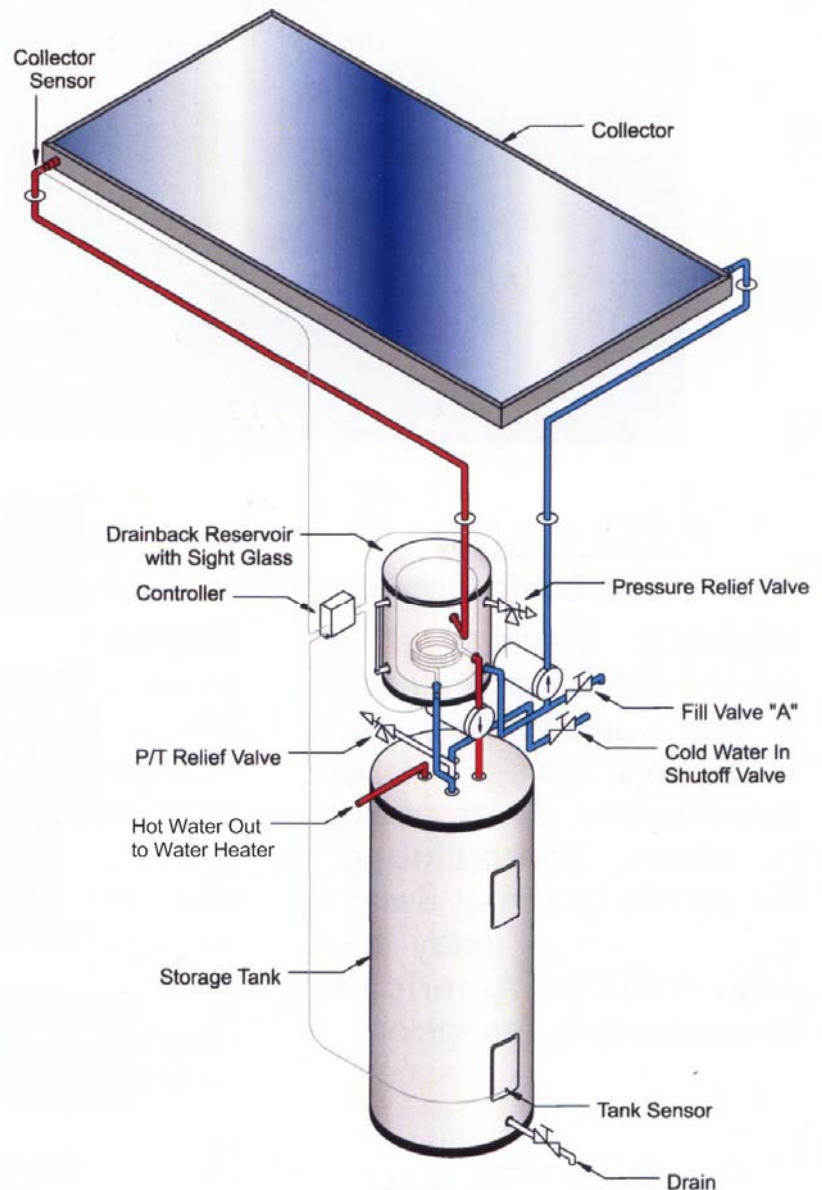
- Flat roof: special mounting equipment required to install the panels at an angle, added cost
- Pitched roof: less equipment/labor required for shingled, residential style roof

**Tax liability:** since so much of the payback is wrapped up in tax incentives, a business or organization should be sure that the owner is able to utilize the tax benefits, which reduce the cost of the system approximately 70%.

**Installation site:** there are a number of site factors that can affect the feasibility of an installation, such as the type and age of a roof, shading issues due to trees on site or mechanical equipment on the roof, and the ability to both locate adequate storage near to and tie into the building's hot water heating system.

### Ideal site conditions include:

- At least 4 full hours of sun on the collectors
- Minimum shading from trees, adjacent structures or roof-mounted mechanical equipment
- Ability to face collectors to within 30 to 45 degrees west or east of due south



## Expected Life

Solar thermal systems have a design life of 20-25 years, and sometimes higher in the case of several manufacturers. This is a mature technology that has been deployed, refined and improved for close to a century.

## Maintenance Costs

Solar thermal system owners should consider a yearly maintenance check. Maintenance costs are minimal and don't impact pay-back year, but are critical to ensuring the long-term optimum performance of a solar system. The most important maintenance needs consist of checking collector fluid levels and testing for pH to ensure an adequate balance of water to glycol. Other maintenance needs are no different from any other commercial hydronic systems: piping, pumps and tempering valves need to be inspected for wear and tear.

## Warranty

Most major manufacturers' collectors carry a 10 year warranty. Other component parts usually carry 1 to 5 year warranties, depending on the type of component and manufacturer. Make sure your solar installer warranties labor.

## Technical Overview

### Major components

**Collectors:** collectors utilize a glycol solution flowing through copper tubes attached to fins to collect heat energy from the sun.

**Storage tank:** after the energy is collected, it is stored until needed in a commercial hot water storage tank.

**Pumps:** a system usually has at least two pumps- one to circulate glycol solution through the collectors, and another to circulate hot water from the storage tank(s) to the end-use in the building (usually the primary hot water heater).

**Controls:** a digital controller with sensors determines when the pumps run. It is programmed to activate the pumps when the collectors are hot and the tank is cold.

**Freeze protection and over-temperature protection:** properly installed systems have insulation on all piping, and the system will also be designed for freeze protection.



## Industry Certifications

### Equipment:

The Solar Rating Certification Council (SRCC) provides third party, ANSI-approved testing for solar thermal collectors. These ratings are the industry's best guarantee that a collector's performance has been reviewed and verified. SRCC certification is required for NC solar tax credit eligibility.

### Solar Installer:

NC Building Code requires that all solar thermal installations be performed by a licensed commercial plumber. The North American Board of Certified Energy Practitioners also offers a nationally recognized solar thermal certification program. (More info: [www.nclicensing.org](http://www.nclicensing.org))

## Solar Thermal Definitions

**Drain-back system:** Uses gravity and water-glycol solution as the heat transfer fluid in the solar loop; the solar fluid "drains back" to the storage tank to prevent freezing or overheating. These systems are more common and cost-effective for many NC applications.

**Pressurized system:** Water-glycol solution stays in collectors at all times. Pumps circulate heat from collectors to tank. This type of system may be used when a drainback design is not feasible due to building height or layout. The water-glycol solution ensures freeze protection. Over-temperature protection is accomplished by storage size, controls and system design.

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