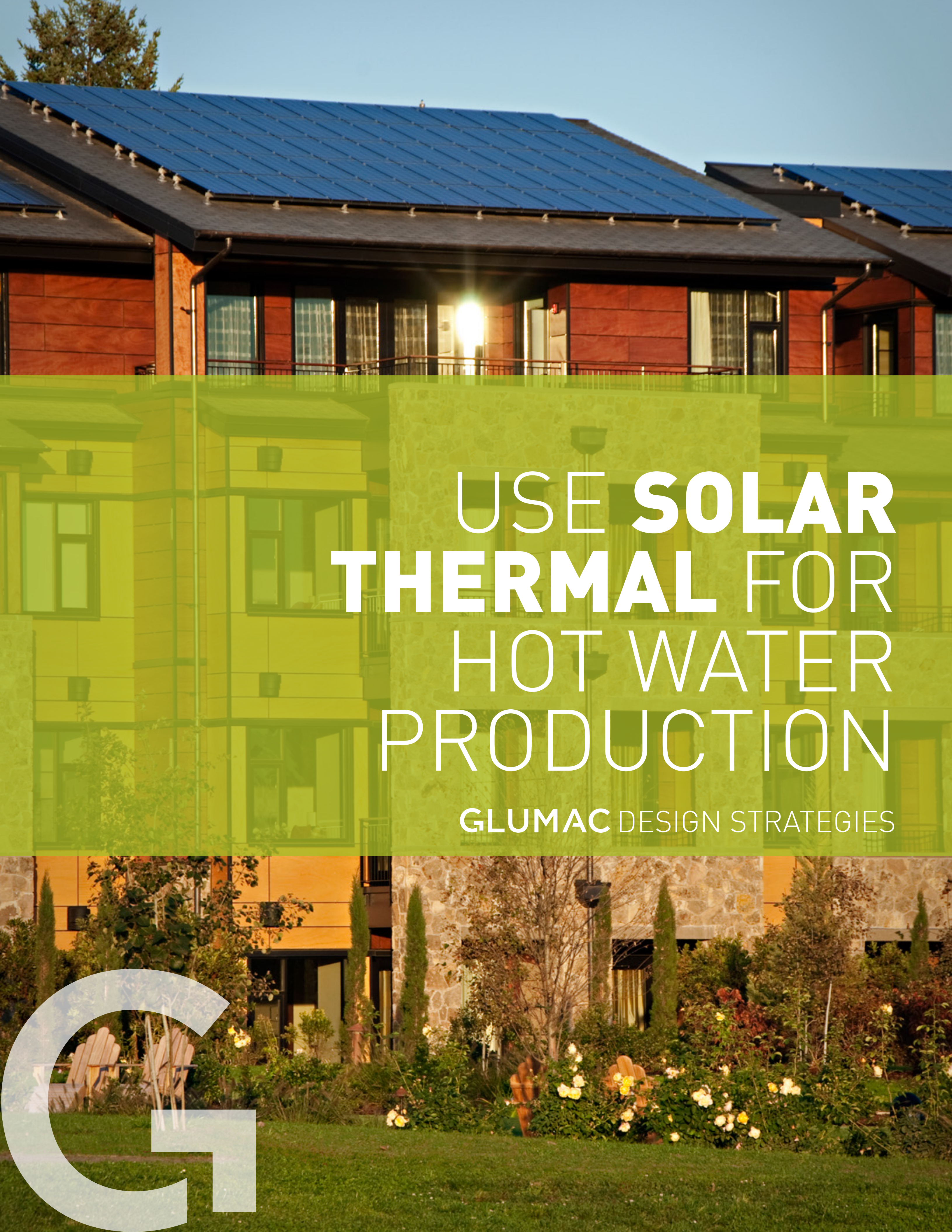


USE **SOLAR THERMAL** FOR HOT WATER PRODUCTION

GLUMAC DESIGN STRATEGIES

SUSTAINABLE HOT WATER SOLUTIONS

SOLAR HOT WATER

Production of domestic hot water by converting direct sunlight into thermal energy – through use of a solar collector to absorb heat, then transfer and store low-, mid- or high-temperature water until needed

Solar thermal offers a cost-effective approach to producing heating, cooling and domestic hot water for all building types. This technology continues to improve and become more popular, due in part to tax incentives and increased interest in renewable energy. Today's solar thermal technologies can meet up to 100 percent of demand – but Glumac typically recommends a hybrid system approach with back-up from alternative sources, especially during winters and nights. Components of a solar thermal scheme include solar panels, a freeze and overheat protection system, storage tanks, pumps and controls. Solar thermal production in cold weather climates must incorporate freeze protection through either a drain-back system or use of a water/glycol solution in the collector loop. Another concern is overheating, which can occur when available supply exceeds demand.

SOLAR PANELS

The process of collecting the sun's energy to

SOLAR HOT WATER: THE ALLISON INN & SPA

produce hot water begins with a choice: flat-plate or vacuum-tube solar panel, or concentrating solar collector. The flat-plate style features copper tubing mechanically bonded to a copper sheet, which is then coated with black chrome to enhance the effectiveness of radiant energy collection. Manufacturers place the complete assembly in an aluminum frame with a glass cover to minimize conduction heat loss. Insulation on the back of the panel also helps minimize heat loss. Water circulates through the copper tubing and pulls heat off the copper plate. This style offers high heat absorption and a uniform, low-profile appearance.

Alternatively, vacuum-tube panels employ a series of vacuum tubes approximately four feet (1.2 m) long, with copper plates and heat exchangers connected to a header. As the temperature of fluid inside the tube increases and vapor rises, the heat transfers to water at the top of the array, then condenses and runs down again. These panels allow for higher water temperatures and dramatically minimize loss from conduction, making them ideally suited for locations with good solar radiation but cooler outdoor air temperatures. Also, they may be oriented at less-than-ideal angles and still perform quite efficiently.

Designers also recommend the use of concentrating panels when high temperatures are necessary for

desalinization or for steam generation to operate a steam turbine or absorption chiller.

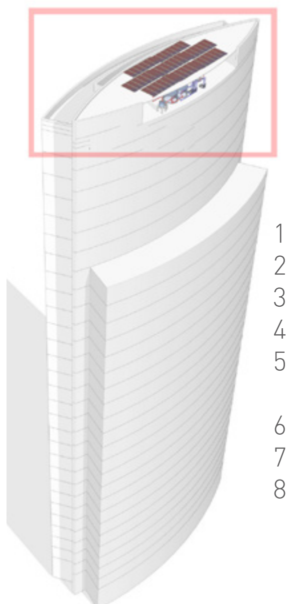
FREEZING AND OVER HEATING PROTECTION

To guard against the loss of panels or piping due to freezing or overheating, solar thermal systems should include one of several fail-safe measures. Glumac prefers the drain-back system, specially designed to prevent both freezing and overheating. This approach also has the advantage of reducing or eliminating the use of glycol, and therefore provides better overall heat transfer efficiency. How it works: during a freeze, pumps shut off and water drains by gravity to the drain-back tank – sized to accept all water in the piping and panels on the roof. Likewise, if hot water demand has been met and the solar tank reaches its maximum temperature, the system's pumps stop and water in the piping/panels drains back to the tank.

A second freeze protection method uses a solution of glycol and water. The amount of glycol – ranging from 35 to 50 percent – depends on winter and summer design conditions. Piping and panels remain full and require no drain-back tank, resulting in a lower initial cost but also lower efficiency. The glycol system fluid must be checked and changed regularly; otherwise this mixture results in a green gooey mess, and a failed system.

To control overheating, designers take one of three approaches:

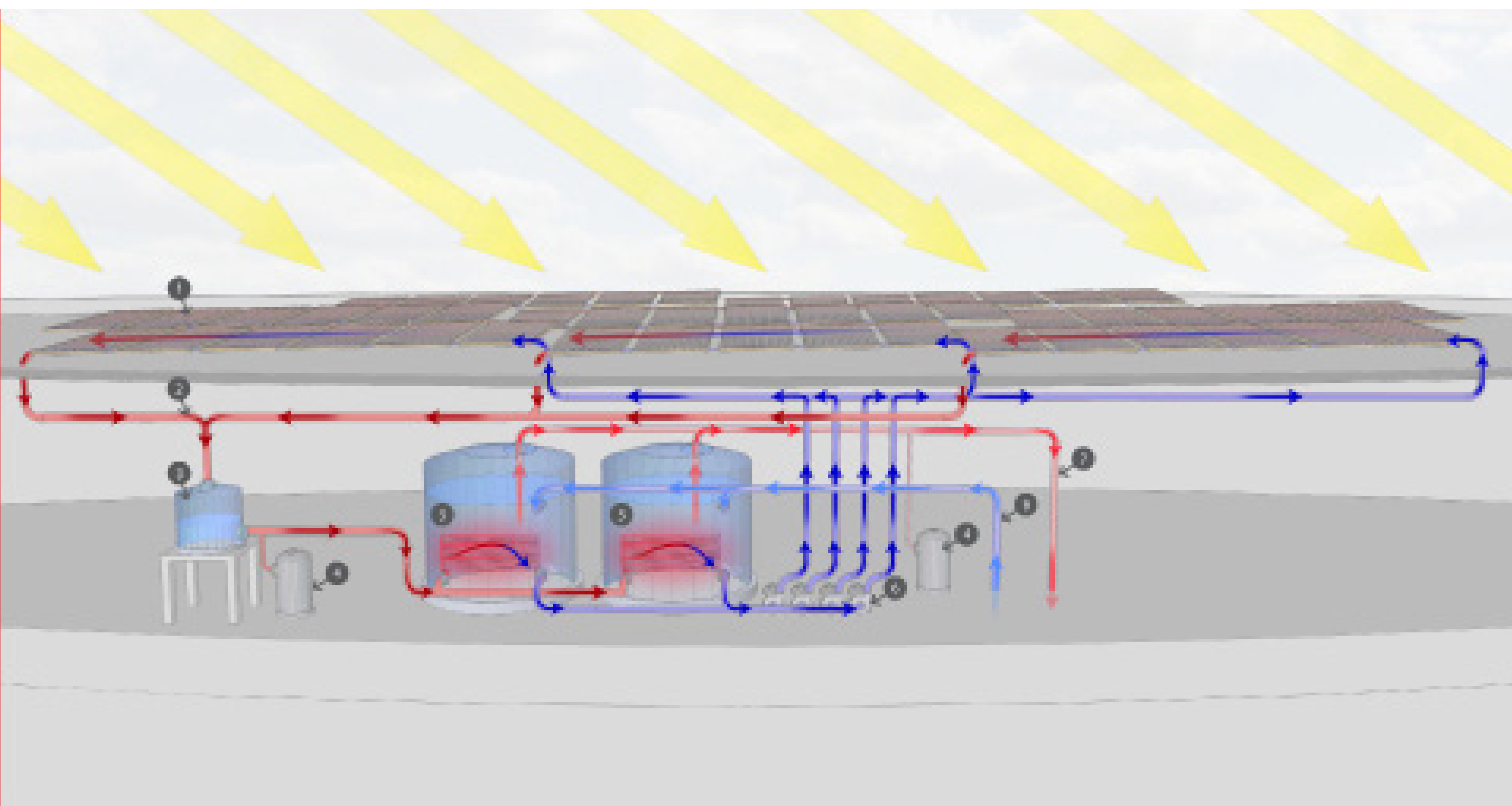
- Utilize a large heat sink, such as a swimming pool or radiator, to divert solar energy; add a drain-back system; or shut off circulation pumps to let solar panels stagnate. This



1. solar thermal panels
2. hot water from panels
3. drain back tank
4. expansion tank
5. 15,000 gallon supply tank with internal heat exchanger
6. solar thermal collection loop pumps
7. building hot water supply
8. potable water supply

SOLAR THERMAL HOT WATER SYSTEM

Rooftop Freeze Protection: Glumac's solar thermal design for the 30-story **Mirabella Portland Retirement Community,** located in the city's South Waterfront area, features a rooftop drain-back system for freeze and overheating protection. Reliance on solar hot water contributes toward an overall 45 percent return in energy cost savings for the LEED Platinum Building.



method, while common in the design-build solar market, offers the least desirable alternative, as it shortens the life of components and can result in hot glycol discharging from relief valves if pressures exceed allowable limits. Glumac doesn't recommend this approach.

PROCESS/TOOLS

Engineers at Glumac consider several key factors when designing a solar thermal system:

- Panel array size: determine the optimal percentage of a building's heating or domestic hot water load based on available unshaded panel area and an economic analysis. Too many panels result in over-capacity during low loads in summer and a longer payback. Typically, solar thermal systems are most cost-effective when sized to provide approximately 50 percent of peak demand
- Storage versus panel square footage: Provide from 1.5 to 2 gallons of storage per square foot (3.75 kL/m3 to 5 kL/ m3) of collector and insulate the storage systems
- Pumping flow rate per collector: Provide 1 gpm to 1.25 gpm (0.06 to 0.08 L/s) per panel – based on a typical array of six to eight panels, resulting in flows of 6 gpm (0.38L/s) to 10 gpm (0.63L/s) for each array
- Drain-back tank size: Provide approximately 1.35 gallons (5.1 L) per panel – based on calculating water capacity according to roof panel and tubing
- Heat exchanger size: Calculate to derive the maximum energy available from panel arrays. Typically, the flow rate into and out of the heat exchanger equals the flow into the panel arrays

FURTHER DESIGN FACTORS

During the system's operation, piping from the solar collector into the building may reach as high as 300ºF/148.9ºC, so designs should consider thermal expansion as well. Penetrations through the roof need to be repairable, as they do not last the life of the roof itself (usually warranted up to 30 years). System designs should maximize tank storage and keep water as hot as safely possible (160 to 170ºF/71.1 to 76.7ºC) for mixing down and distributing to building plumbing fixtures.

Heated water can then flow from the tanks into a regular domestic hot water system. Finally, panel mounting design needs to account for panel weight, wind load, snow load and cleaning. Installing a hose bibb to facilitate cleaning of panels is recommended. G

A 3,800-square-foot array powers the PV system for the **Allison Inn and Spa** – an 85-room luxury resort in Oregon's wine country – producing enough energy to preheat water for the facility's kitchen, laundry, guest rooms, and pool.