Solar Solutions

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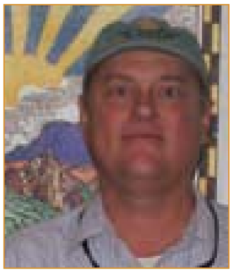

Bristol's Six Principles for Good Solar Hydronic Design

Solar Combisystem – Case Study in Los Alamos, N.M.

When the time came for the old Los Alamos landfill to be upgraded to a modern solid waste transfer and recycling center, the County took the opportunity to create a public showcase for energy efficiency and sustainability. The new headquarters building was designed from the ground up to include many of the solar hydronic features we have been discussing here in this column. The system heats domestic hot water and radiant floors with a bank of seven, flat plate solar collectors. A high-efficiency boiler/storage tank provides solar heat storage and automatic backup for both heating loads. It also includes web-connected multi-stage room thermostats and night sky radiant cooling in summer.

One way to generate community interest in solar heating is to put it on public display. Despite its humble utilitarian purpose, the building serves as an excellent center for public education. Sooner or later, virtually everyone who lives in or near the town of Los Alamos makes a trip to "the dump," or at least drives past it on the highway. And when they do, they can't help but notice the solar collectors on the front of the building and the other sustainable features put to practical use in this facility.

Los Alamos County "Eco Station" (Solid Waste Transfer Station)

Construction of the Eco Station began in August 2007 and it opened in November 2008.

The facility is designed for Leadership in Energy and Environmental Design™ (LEED). The County Council took action in 2006 to require that all new County owned building projects be designed and built to meet at least LEED Silver standards, have 25% better energy efficiency than a standard building and incorporate water savings measures.

The Eco Station is a demonstration project for Los Alamos County and the State of New Mexico of green building and alternative energy. It is the County's first green building project. Los Alamos County has a goal to become hydrocarbon independent, and thus plans to build energy efficient buildings and incorporate alternative energy wherever possible. As a result, the administration building at the Eco Station includes solar heating and hot water — which was made possible by support from New Mexico Energy Minerals and Natural Resources Department.

The LEED design is reflected in the project's name — the County named their new transfer station the Eco Station because of the green building concepts and focus on recycling. The County was already recycling 40% of the material that came to the landfill, and the Eco Station now provides opportunities to recycle even more. Asphalt, concrete, brush, metal, tires, oil, batteries, cardboard and mixed commercial and residential recyclables are all recycled.

System description

This solar heating system integrates space heating and domestic hot water heating into a single system similar to the "Combi 101" system often discussed in this column. The controls intelligently distribute heat from the solar collectors and a natural gas backup boiler to various heating loads employing a system of temperature controllers, pumps, tanks, heat exchangers, and thermostats. The concrete radiant heated floors are insulated underneath with "blueboard" foam and are used as thermal mass to store solar space heat by day, comfort-controlled by the 2-stage room thermostats. An insulated 80-gallon water tank increases the solar heat storage and is also used for domestic hot water (DHW). There are two sets of showers located in the building, so the DHW usage is higher than a typical office building.

The building was designed with a solar orientation. Flat plate solar collectors are oriented to true south on a vertical wall and filled with a 50% mixture of non-toxic, high-temperature-inhibited propylene glycol and 50% water. One direct current pump, powered by a 30-watt photovoltaic (PV) module, circulates the glycol/water mixture through the solar collectors. The glycol solution gains heat as it passes through the collectors then circulates to the mechanical room through insulated copper tubing. Once inside the mechanical room, the glycol solution passes through a flat plate liquid-to-liquid heat exchanger and back to the collectors. Boiler fluid (water in a closed loop) is heated by the exchanger and then circulates through the primary check-loop to the heating loads.

Use of a photovoltaic power source for the solar loop eliminates the need for controls to start or stop the solar circulating pumps when solar energy is available. Additionally, using a photovoltaic panel to power the glycol pump allows collector fluid to continue to circulate through the collectors even in the event of a grid power failure during sunny weather.

Heat is delivered into a primary check-loop and distributed to the living areas through radiant floors by circulating heated boiler fluid from the primary loop through cross-linked polyethylene (PEX) tubing in the floors of the building. This fluid is heated by the solar collector loop heat exchanger or by the burner in the boiler. Automatic tempering valves are provided to maintain a safe and comfortable operating temperature for the PEX tubing.

Heating system control is accomplished using two-stage thermostats connected to zone controllers. Thermostats communicate directly with the zone controllers which open zone valves and start circulators according to temperatures in the building. A group of Tekmar digital controllers are used read solar collector fluid, primary loop, storage tank and domestic hot water temperatures. These digital controllers determine which source of heat should be used to satisfy the thermostats.

Summer cooling in the building is accomplished in two stages. First priority is night sky radiant cooling, which can pre-cool the thermal mass of the floors at night whenever the

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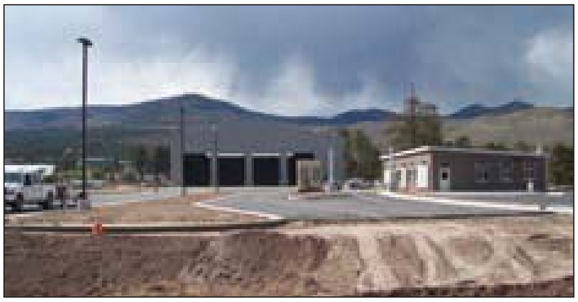

Figure 1, Waste Transfer Station Facility components include Viessmann Solar Collectors, Vitosol 100, flat plate, internal headers with vertical orientation and white shipping covers still in place.

Figure 4. Roof of Eco Station features Heliocol HC-50 unglazed plastic radiator panels for cooling.

Figure 2. Hydronic tubing layout with HePex radiant on a cold winter's day.

Figure 3. South face of Eco Station uses PV panel for solar glycol pump (30-watt rating) and Viessmann solar heat collectors with shipping covers removed.

weather permits. Heat is removed from the mass floors by circulating boiler fluid through the floors at night, passing this heat "backward" through the solar heat exchanger, warming the solar glycol at night. The warm glycol is circulated through unglazed panels mounted horizontally on the roof, where it is cooled by radiation from the night sky. A refrigeration air conditioner is available to cool the building through the fresh air ductwork as a summer backup system only when the night cooling is unavailable.

System components

Since a picture is worth a thousand words, I am including construction photos of the Eco Station administration building. The major components can be located with the photos.

Not shown in photos — Prolifix NT120 web-connected thermostats.

In closing

The engineer in Los Alamos County who deserves much of the credit for guiding the Eco Station from concept to operation is the Environmental services manager, Regina Wheeler. The building is available for tours. For more information, look up the web site: www.losalamosnm.us/PROJECTS/ENVIRSERVPROJECTS/Pages/EcoStation.aspx.

In the construction photos, the final pipe insulation has not been installed on most of the exposed copper pipe. High temperature pipe insulation is recommended. Brand names, organizations and manufacturers are mentioned in these articles only to provide examples for illustration and discussion and do not constitute any recommendation or endorsement. ■

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Figure 5. Hydronic heating system in mechanical room. Components include: Voyager 80-gallon stainless steel storage tank with condensing boiler gas back up for heat and domestic hot water; Taco circulating pumps (green pumps); Crown "brazed plate" heat exchanger CBP5X12-20 (foreground right); Laing PV-direct solar glycol circulator (small bronze and black/silver pump); Taco EBV zone valves (near the floor); ZVC control boxes and SR relay enclosures (green boxes); and Tekmar 155 and 152 differential and set-point controls (mounted on gray box).

In this series of articles, I have been making the case that the key ingredients for solar/hydronic design and installation can be divided into six categories, listed below, roughly in order of their importance.

1. RELIABILITY
2. EFFECTIVENESS
3. COMPATIBILITY
4. ELEGANCE
5. SERVICEABILITY
6. EFFICIENCY

The success of any solar hydronic home heating installation depends on the often-conflicting balance between any of these six principles. Finding the balance between them defines the art of solar heating design.