

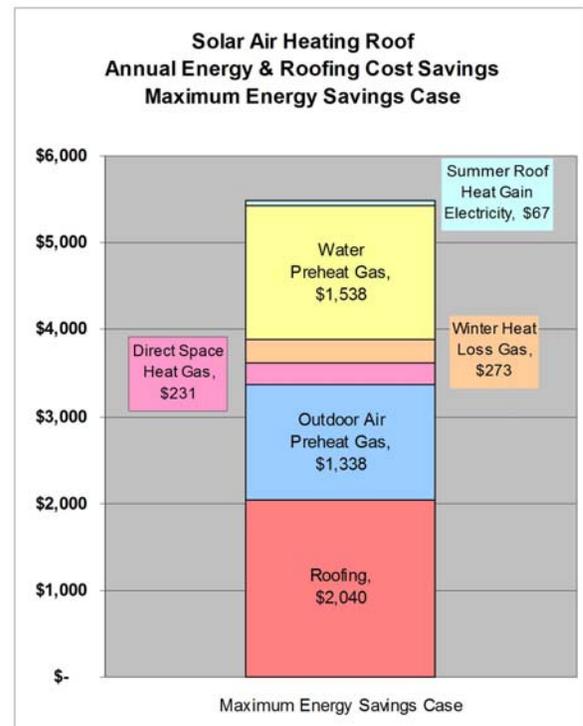
## Gaffney Fitness Center: Solar Air-Heating Roof for Space Heating, Water Heating, Cooling, and Roofing Savings



American Solar, Inc. designed and installed a solar air-heating re-roof at the Gaffney Fitness Center at Fort Meade, Maryland.

The innovative solar air heating metal roof uses conventional, metal roofing to provide a long life (40 year), weathertight roof and to serve as a solar air heating collector. The solar air heating roof provides space heat and domestic water heat and keeps the building warmer in winter and cooler in summer than the existing built up roof. The solar metal roof saves over \$5,000/yr, and approximately \$200,000 over the 40 year life of the 9,275 square foot roof.

The innovative use of the metal roof panel as both the roofing material and the solar collector surface greatly reduces the cost of collecting solar energy for heating. The collection of solar heat via heated air makes the system extremely efficient and productive at air-heating, which is typically the largest building heating load. The system also provides sufficiently high solar air temperatures for water preheating from a conventional air-to-water heating coil.



The Gaffney Fitness Center is a 45,000 square foot, 2 story building, built in 1973 and heated by natural gas fired boilers feeding hot water loops. The facility has various workout and training rooms, a pool, locker rooms, offices, and a gym that has been converted to a large exercise room. In 1987, the roof needed repairs and was subsequently replaced with a new built up roof. By 2010, this second roof had leaked and been patched in many locations and needed to be replaced.



With the solar re-roof, the old roof is covered with a long life, weathertight roof and solar heated air is delivered to the building to supply: direct space heating of the gym, outdoor air preheating for the gym, and domestic hot water preheating.

**Solar Roof** – American Solar installed the solar roof using conventional standing seam metal panels on framing installed above the old roof on a southwest slope of 2” in 12”. The dark-colored metal roof panels serve as both a weathertight roof and a solar collector surface. Sunlight heats the metal roof surface, which heats the air in the space just below the metal panels. That solar heated air is drawn through fans and ducts to; heat the building, heat domestic hot water for sinks and showers, and heat the outdoor air entering the main air handler.



The components of the Gaffney solar roof include:

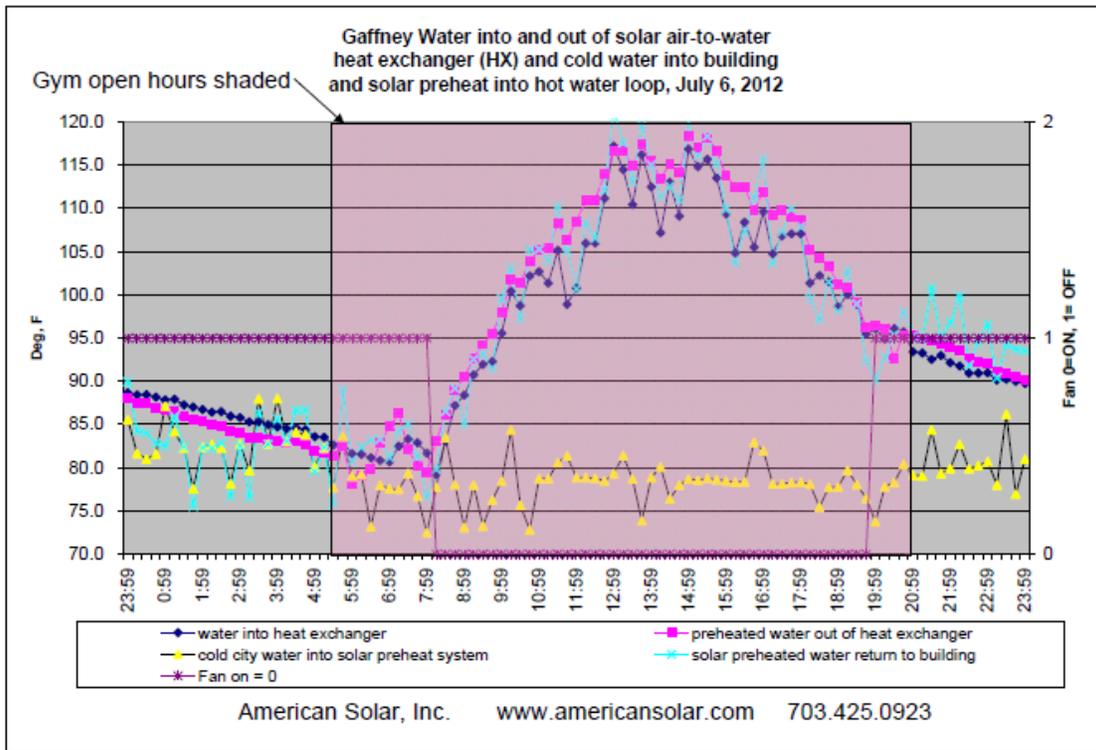
- A *Support Structure* above the old roof that creates a solar-heated airspace and secures the new roof to the building.
- *Insulation and a Radiant Barrier* to keep the building cool in summer, warm in winter, and contain the solar heated air.
- *Fans and Ducts* to move solar-heated air through the system.
- An *Air-to-Water Heat Exchanger, Storage Tank, Pump, and Valves* to pre-heat water with solar heated air.
- *Controls* to start the fans and pumps when solar heating is required.

**Performance** - The solar roof can heat air at the rate of 64 BTU per square foot of roof per hour. For outdoor air preheat for ventilation the Gaffney system typically delivers over 40,000 BTU per square foot from October to April. For direct space heat, the system delivers 10,000 BTU/sqft/yr. For water preheat, the system delivers over 33,000 BTU/sqft/year. Testing showed that solar air temperatures will regularly reach 25-30°F hotter than outside air temperature, delivering solar air at well above 100°F for more than 1,000 hours per year, which is ideal for preheating domestic hot water.

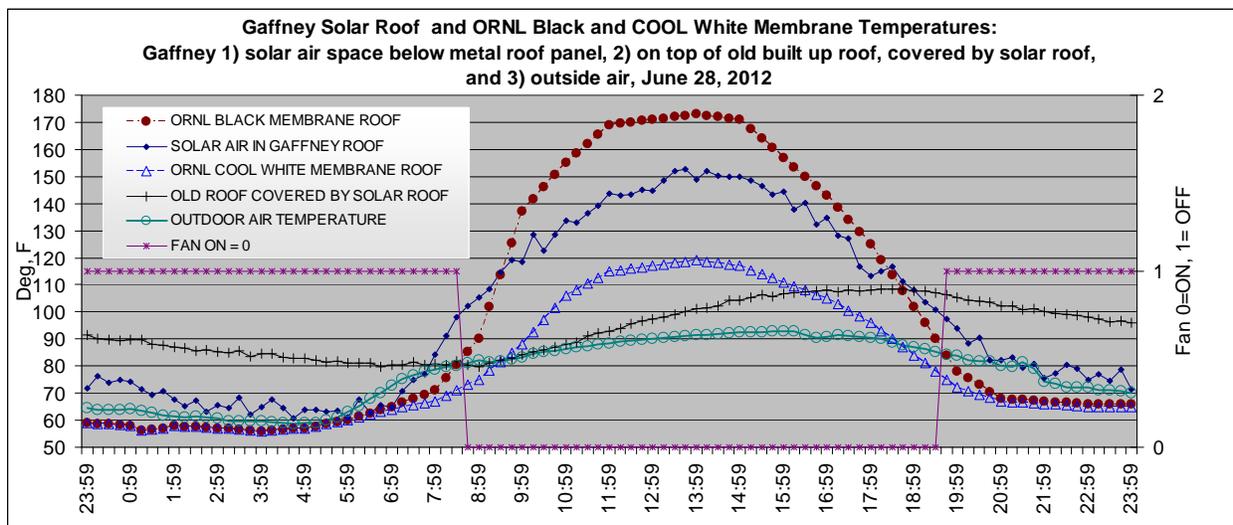
**Outdoor Air Preheat** - The solar heated outdoor air is delivered from below the roof to the outdoor air intake of the main air handler for the gym. The solar air flow is 3,800 cubic feet per minute, matching the minimum outdoor air required for the air handler. The system saves as much as 250,000 BTU/hr and 1.1 BTUs of natural gas for every BTU of solar heat in the preheated outdoor air.

**Domestic Hot Water Preheat** - The solar air-to-water preheat system is designed to preheat water up to a temperature of 120°F for daily use within the building. The solar air-to-water heating system uses a 1,900 CFM fan, an air-to-water heat exchanger, a 40-gallon preheat tank, and an 11 GPM pump. The pump and fan run whenever the solar air temperature is above 45°F and is warmer than the water in the storage tank. The system delivers a maximum of 55,000 BTU per hour to the water with an electric use to run the fan and pump of only 1,600 watts (~5,500 BTU/hr equivalent), ... a 91% energy savings compared to gas boiler water heating. The chart below shows the system delivered preheated water to the domestic hot water boiler for 13 of the 16 hours that the gym was open on July 6<sup>th</sup> 2012. Total heat transfer was 252,000 BTU for the day.

Case Study: ASI Solar Air Heating Roof for a Fitness Center, Fort Meade, MD



***A Roof that is Warmer in Winter and Cooler in Summer*** – The Solar Air-Heating Roof creates an insulating layer of air above the old roof that it covers. For the Gaffney facility, that insulating layer keeps the roof an average 19°F warmer in winter than the old built up roof alone. This reduces heat loss through the roof system and saves over 23 million BTU/year in heating season natural gas use.



During the summer months, the solar roof actually keeps the old built up roof beneath it as much as 65°F cooler than the exposed built up roof or a black membrane roof. In fact, the

performance of the ‘hot’ solar roof at reducing heat transfer through the roof and down to the building below, is as good as a ‘cool’ white roof. The graph above shows the temperature of the old built up roof covered by the solar roof, and the temperatures of a ‘cool’ white membrane roof and a black membrane roof. These membrane roofs were tested by Oak Ridge National Lab (ORNL) under similar weather and solar conditions as the Gaffney roof. The ‘cool’ white roof reaches 120°F during peak cooling hours when electric rates are highest. The old roof under the solar roof never gets above 110°F, reducing heat transfer through the roof and lowering cooling costs during peak rate periods. In addition, the solar roof recovers the heat for domestic hot water heating to lower utility expenses, ... something that the “cool” membrane roof can not do.

The solar air heating re-roof of the Gaffney facility was funded by the DOD Environmental Security Technology Certification Program, and it included funding for extensive monitoring of the system performance. The monitoring systems measured building roof temperatures and temperatures and flows of solar-heated air and domestic water over summer cooling and winter heating periods. Over half a million data elements were collected and analyzed along with local solar and weather data, to document the solar heating and cooling performance of the roof. The performance evaluation, which was reviewed by the Army Corps of Engineers Construction Engineering Research Laboratory, verified that the solar roof is capable of producing solar heated air at a rate of 60+ BTU/hour/square foot of roof. The performance model that was created from the data analysis enables accurate calculation of solar roof energy saving performance for any building solar re-roof.

The solar air-heating roof system, like the one at the Gaffney Fitness Center is installed entirely of standard commercial components; including the new metal roof, heating systems, and insulation. Installation is straightforward using conventional, roofing and HVAC systems, installed exactly as they are in millions of other buildings. The solar heat recovery techniques are easily applied to all types of buildings that need to lower their energy and roofing costs. The re-roof over an existing roof eliminates a tear-off and disposal of the old roof. This protects the interior during the re-roof and adds to the insulating value of the roof compared to re-applying the same roofing system. The re-roof usually cleans up roof drainage problems by providing steep slope roofs and gutters, where ponding and clogged drains on flat roofs have caused leaks and damage to tenant spaces below.

When installed during a routine re-roofing of the building, the energy and roofing cost savings over time will more than pay for the cost of the re-roof. This makes the solar air-heating metal roof one of the lowest cost, most productive solar energy systems that can be installed.

**American Solar, Inc.** has designed and installed all the largest solar air heating roofs in North America. The company has installed these roofs for a variety of heating purposes, including; direct space heating, water heating, combustion air preheating, paint booth heating, dehumidification, and equipment heating.