Solar Hot Water Design

Introduction

For proper analysis of the solar hot water heating system the results obtained from the eQuest energy model are used to determine service hot water loads. In addition, hot water produced by the 60kW of cogeneration is also considered. Natural gas prices have been obtained from the Nevada Power Company. In addition to the eQuest energy model that was used, RETScreen International's solar hot water design tool was used to determine feasibility, cost effectiveness, and greenhouse gas savings for the solar hot water heating system.

Design Goals

Ultimately, the main goal of this analysis is to determine the feasibility of installing (6) 10'x4' solar hot water collectors. I am attempting to determine whether this is a viable design option based on criteria of building service hot water load, cost analysis, roof area available and a greenhouse gas analysis. It is hoped that the panels will have a payback time of less than 10 years, produce significant savings in greenhouse gases and fit in the space available on the roof. The panels must also make sense in terms of the building's service hot water demand and the hot water produced by the cogeneration system. After the analysis, conclusions will be drawn as to the viability of installing 6 solar hot water collectors.

Design Solution

To add to the building's available hot water I decided to examine the results of installing (6) 10'x4' solar hot water panels. The panels chosen were SunEarth, Inc. model Empire EC-40 (See Appendix D-CD for cutsheet). The motivation for installing the panels was attempting to reduce the greenhouse gases caused by natural gas being combusted in a traditional boiler. The small amount of surface area of the collectors is due to limited space as much of the prime space is taken up by the photovoltaic system.

Analysis

Roof Area

Due to the size of the solar hot water panels and limited roof space available, it was vitally important to find space that met numerous requirements. The first requirement is that the panels must not block the photovoltaics or the skylights. Next, they must have a predominantly south-facing exposure for maximum energy gain. And lastly, and perhaps most importantly, there must be enough room for all six of the panels. After investigating the roof plan, the space directly south of the atrium skylights was judged to be the best location (see figure 4.1). The atrium skylights are up on a curb, raising them above the roof line, so even when angled the solar panels will not shade the atrium skylights. However, there is a skylight to the south of the panels that would shade the panels themselves. It is not very big when compared to the size of the panels though, so it will not effect the panels' output to an extreme degree. One downside to the location is that it is situated in between 2 pieces of mechanical equipment which may may maintenance on the mechanical equipment and the solar panels themselves difficult.

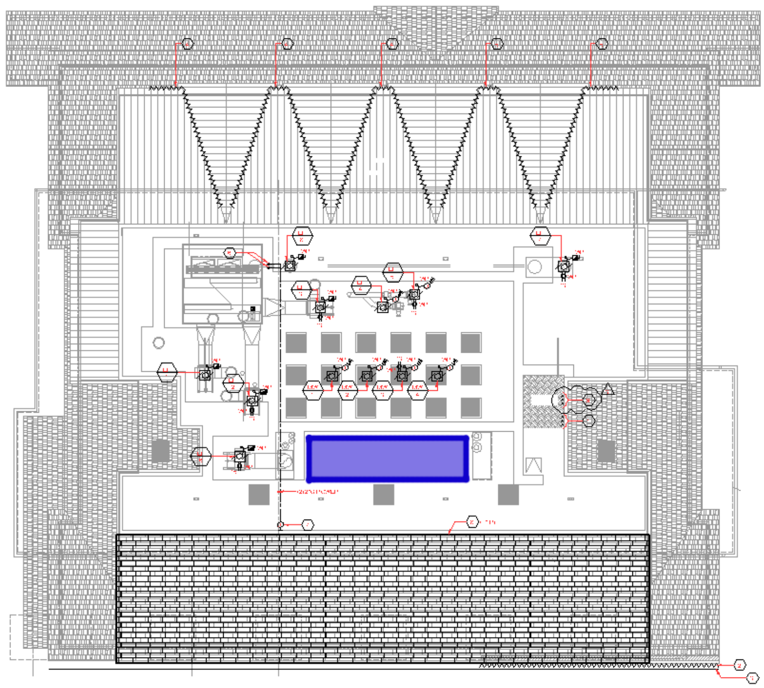

Figure 4.18 - Blue = Proposed location

Greenhouse Gases

The RETScreen solar hot water heating program was used to determine the greenhouse gas savings as compared to a natural gas fired boiler. The net reduction in CO2 using the solar hot water heating panels is 2.51 tons of CO2 as can be seen in table 4.2 below. Compared to the savings from the cogeneration system (page 54) and the photovoltaic system (page 58) this is a negligible amount of greenhouse gas emissions that are saved. For additional details on calculations done and figures used, please see the spreadsheet located in Appendix D-CD.

RETScreen Output		
Grid GHG emissions (tCO2)	***SHW GHG emissions (tCO2)***	***Net annual GHG reduction (tCO2)***
2.51	0	2.51
		Table 4.2

Payback

To determine the payback period, the RETScreen tool was used in conjunction with cost information contained in the RETScreen product database and pricing for natural gas was obtained from Nevada Power. A price of $65 per square meter of collector was used along with a $250 cost to repair valves and fittings every 10 years. The payback period is 16 years, which exceeds the 10 years that was hoped for. For more detailed information on the cost information used, please see the spreadsheet in Appendix D-CD.

Yearly Cash Flows		
Year	**Yearly**	**Cumulative**
#	**$**	**$**
0	(2,973)	(2,973)
1	172	(2,800)
2	177	(2,623)
3	183	(2,440)
4	188	(2,252)
5	194	(2,058)
6	200	(1,858)
7	206	(1,653)
8	212	(1,441)
9	218	(1,223)
10	(111)	(1,334)
11	232	(1,102)
12	238	(864)
13	246	(618)
14	253	(365)
15	261	(105)
16	268	164
17	276	440
18	285	725
19	293	1,018
20	(149)	868
21	311	1,180
22	320	1,500
23	330	1,830
24	340	2,170
25	350	2,520

Table x.20

Service Hot Water

From the eQuest simulation performed, I determined that an hourly load of 2.2 million

BTUs was sufficient to heat the building (for complete eQuest output as well as input files, please see Appendix B-CD). The cogeneration units together produce 0.3 million BTUs per hour, leaving an additional 1.9 million BTUs per hour that need to be addressed by either the solar hot water system or the natural gas fired boiler. The panels, however, only produce 0.049 million BTUs per hour. This is insignificant compared to the additional load that the building requires during the day.

Conclusions

Due to the long payback period, the insignificant amount of hot water given, the tight squeeze into the available space, and the small amount of savings on CO2 emissions, I recommend not installing the solar hot water hearing system. The 16 year payback period does not make it economically feasible, and since it has no other visible benefits other than a very small amount of greenhouse gas savings, it would be hard to justify the extra cost to the owner.