Hi All,

I used Gary's free Radiation on Collector program (http://www.builditsolar.com/Tools/RadOnCol/radoncol.htm) to help me determine the best collector tilt and azimuth orientation in our yard. I wanted to find out how important the tilt angle is and how much efficiency I would lose if the collector isn't pointed exactly south (azimuth).

I can build any tilt angle I want, but orientation towards south is a consideration. That is mainly because I start to get some shade around 2:00 PM at one of the sites I'm considering, so I thought I would see how maximizing the morning sun would work out. As the following charts and graphs show, the results are really interesting!

Using Gary's program, I ran the data for my latitude (39.5 degrees) for January 21 - the coldest day of the year and February 21 - when the sun is much stronger but temperatures are still cold.

I also calculated data for three different azimuths - the collector pointed towards where the sun would be at noon (due south), towards the sun at 11:00 AM (15 degrees east of south) and towards the sun at 10:00 AM (30 degrees east of south) with a variety of tilt angles. Here is a chart of the raw data showing the total BTUs hitting each square foot of the collector during the day for each orientation:

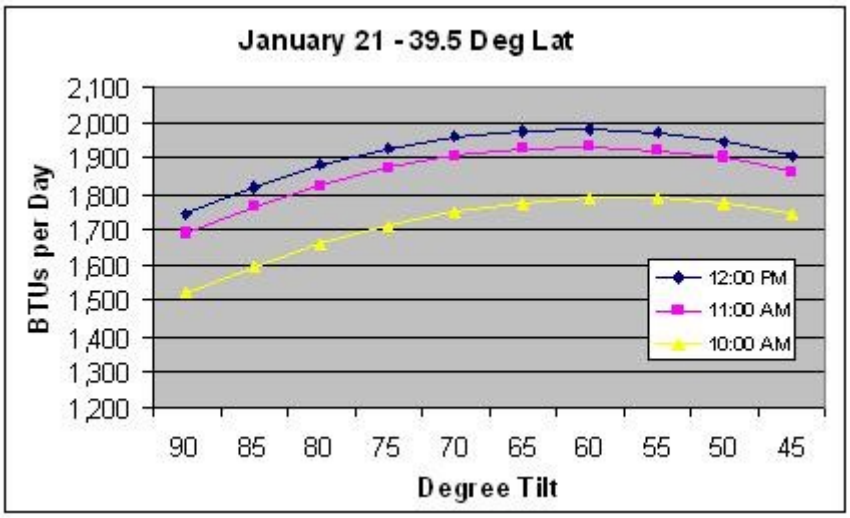
	Total BTUs per square foot on collector per day									
	Assuming latitude of 39.5 and 400 feet above sea level									
21-Jan		Degree Tilt								
	90	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**45**
12:00 PM	1,746	1,820	1,881	1,928	1,960	1,978	1,982	1,971	1,945	1,905
11:00 AM	1,689	1,763	1,824	1,872	1,906	1,926	1,932	1,924	1,901	1,865
10:00 AM	1,521	1,596	1,659	1,710	1,748	1,774	1,787	1,786	1,773	1,746
21-Feb		Degree Tilt								
	90	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**45**
12:00 PM	1,742	1,851	1,947	2,028	2,095	2,146	2,182	2,202	2,205	2,192
11:00 AM	1,685	1,795	1,891	1,974	2,042	2,095	2,133	2,155	2,162	2,152
10:00 AM	1,539	1,643	1,739	1,825	1,896	1,954	1,998	2,027	2,041	2,041

Again, the 12:00 PM line is the data for a collector built to point directly towards the sun at noon, the 11:00 AM line is for a collector pointing directly towards the sun at 11:00 AM and the 10:00 AM line is for a collector pointing directly towards the sun at 10:00 AM.

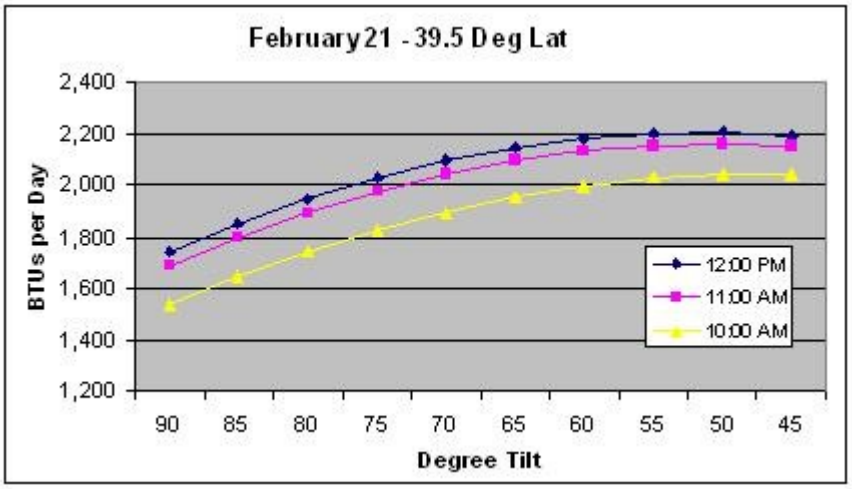
One thing jumps out right away. For winter solar space heating, a tilt angle in the neighborhood of 55 - 65 degrees is the sweet spot, but there is plenty of tolerance that will still provide very good performance.

Secondly, using the data for January 21st, a collector tilted at 60 degrees towards the 10:00 AM sun will get a daily total of 1,787 BTUs per square foot, while a collector pointed towards the noon day sun will get a daily total of 1,982 BTUs per square foot - a difference of only 195 BTUs. That means the 12:00 oriented collector only represents a 10.9% improvement over the 10:00 AM oriented collector. The 11:00 AM orientation is almost as good as 12:00, with only a 2.6% improvement between the two!

This graph shows the January 21st orientation data:



And here is the February 21 orientation data:



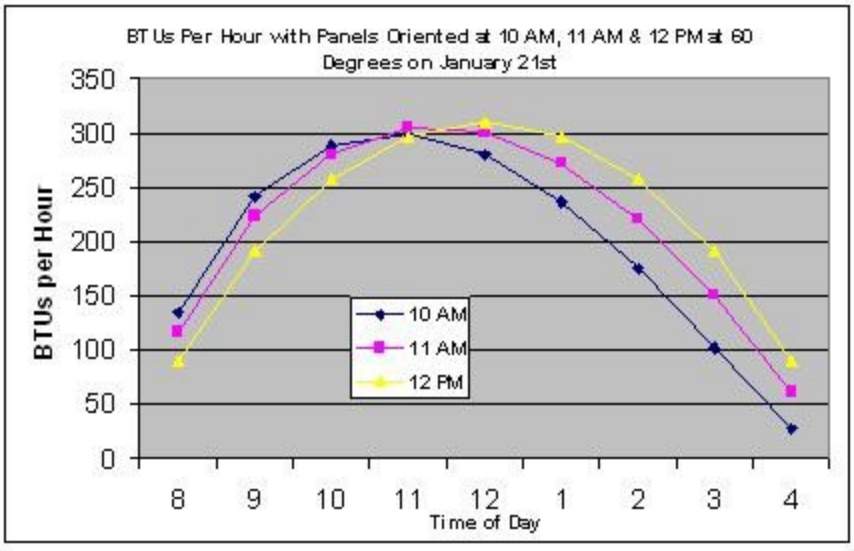
Don't let the gap between the 10:00 AM and 12:00 PM line fool you. As you can see, the chart's Y axis starts at 1,200 BTUs per day. An upcoming chart will better show how close the options really are.

Since building 10% bigger for the 10:00 AM orientation to match the performance of a 12:00 PM orientation is an easy choice for me, I next wanted to determine how much quicker I would get heat in the morning. Two hours earlier between those two options, right? - Wrong! The data and pictures tell the tale:

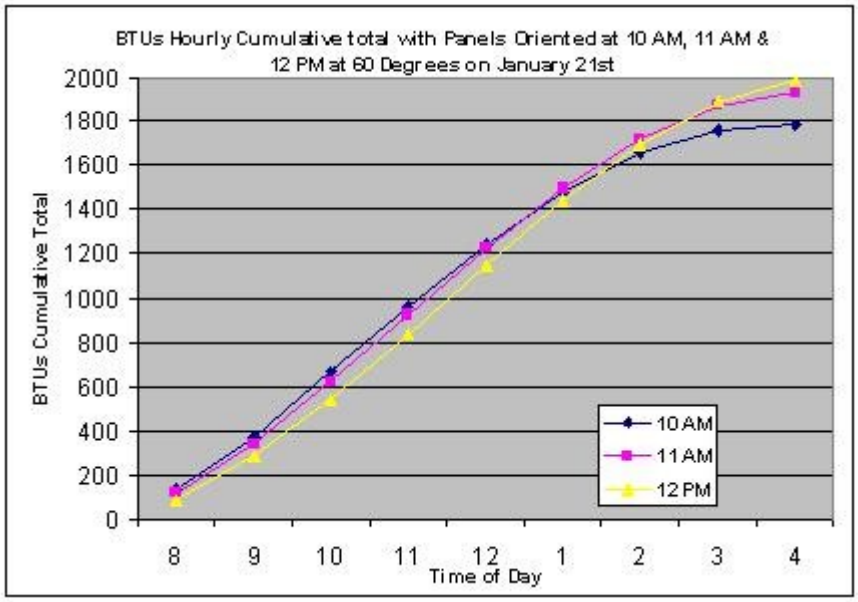
Here is the raw data showing the BTUs striking the collector each hour for each of the three orientations:

	BTUs at 60 Degrees 1/21		
	Collector Orientation (degrees)		
	10 AM	**11 AM**	**12 PM**
8	135	116	91
9	242	223	192
10	289	280	257
11	299	305	296
12	280	302	309
1	237	273	296
2	175	221	257
3	102	150	192
4	28	61	91
	BTUs at 60 Degrees Cumulative total 1/21		
	Collector Orientation (degrees)		
	10 AM	**11 AM**	**12 PM**
8	135	116	91
9	377	339	283
10	666	619	540
11	965	924	836
12	1,245	1,226	1,145
1	1,482	1,499	1,441
2	1,657	1,720	1,698
3	1,759	1,870	1,890
4	1,787	1,931	1,981

Here is a graph showing the comparison hour by hour:



Here is the graph that shows the cumulative total for each hour. This graph also most clearly demonstrates how close in performance the various azimuths really are:



In my case, the 12:00 PM azimuth orientation line would start to be level after 2:00 because of shade, so the cumulative effect of the orientations would be about the same.

I thought this was really interesting and encouraging data. We have enough information to maximize our efficiency, but we also have plenty of flexibility to adapt to our individual circumstances!

I know that in some cases folks have trouble viewing images in e-mail, so I have created this report in a Word document and uploaded it here:

Take care,
Scott