Measured Energy Savings for Solar and Boiler Projects Installed at an Oregon Swimming Pool

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ABSTRACT

The Hood River Aquatic Center installed two projects in July 2006 to reduce their natural gas use. They installed a solar water heating system for the main pool and a high efficiency condensing boiler system. The pool gas use has been reduced by 27%. This article provides a background of the projects and presents the measured energy savings.

THE FACILITY

The Hood River Aquatic Center is a municipal pool located in north-central Oregon. It opened in 1993, the building is 23,000 square feet in size, and contains three indoor pools (see Table 1).

Table 1. Pool Specifications

Main Pool	85°F	280,000 gallons	5,000 square feet
Warm Water Pool	90°F	30,000 gallons	1,000 square feet
Kiddie Pool	88°F	2,500 gallons	500 square feet

The facility is open to the public 340 days a year, from early morning to late evening. The walls and roof are made of an inner and outer layer of plastic. The center roof and wall sections are removed in the summer (see Figure 1).

Solar Pool Heating System Upgrade

A drain-back style solar heating system was installed to heat the main pool water (see Figure 1). There are 48 non-glazed plastic collectors covering 2,300 square feet of the roof. The original intent was to install 96 collectors on the ground but permitting restraints prevented this. The system operates from mid-April though mid-October to heat (or pre-heat) the main pool water whenever there is sufficient sunlight.

High Efficiency Boiler System Upgrade

A new high efficiency condensing hot water boiler was installed (see Figure 2). New hot water pumps, piping, and plate & frame heat exchangers were also installed. The original 1993 low pressure steam boiler system was removed along with the steam piping and three heat exchangers. A new web-enabled DDC system was installed to control the boiler system and monitor the boiler and solar systems.

MEASURED NATURAL GAS SAVINGS

There are two natural gas meters serving this facility. The meter serving the boiler room is the focus of this study – it only serves the pool boiler and the domestic water heater. There is a separate meter that serves the space heaters. Both the boiler project and the solar project generate savings from the boiler room gas meter and do not affect the

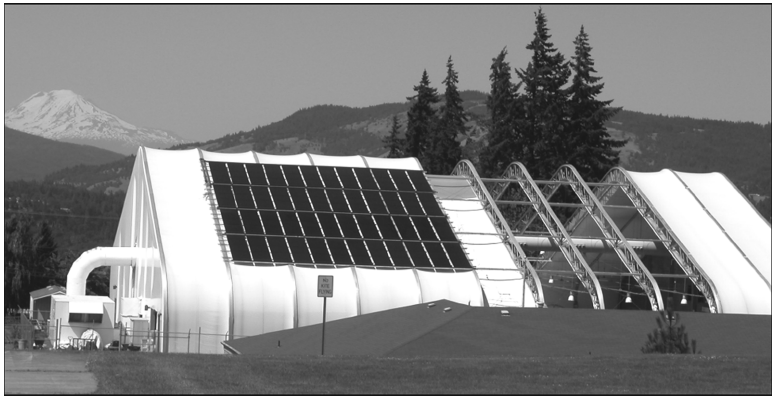

Figure 1. Solar System and Open Pool Roof. (Photo Credit: Brent Gunderson, Gen-Con Solar)

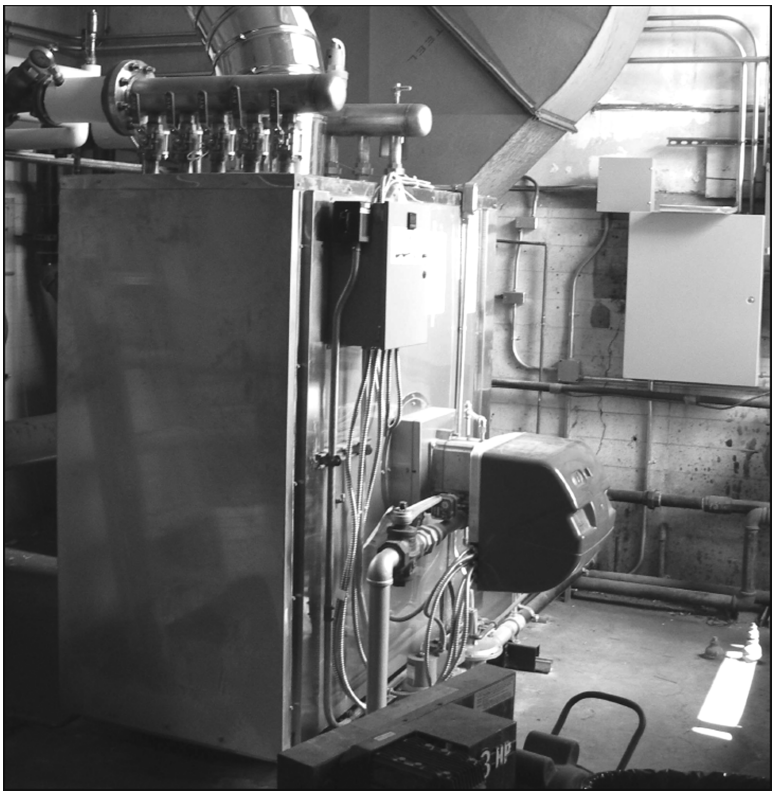

Figure 2. New High Efficiency Boiler. (Photo Credit: Steve Rubbert, Enertia Energy, Inc.)

space heating gas meter.

The natural gas bills serving the boiler room have been analyzed and the gas savings have been measured from the actual bills. The existing (baseline) gas use was determined based on the average gas bills for 3-1/2 years. The post-upgrade gas use was determined based on the average bills for 20 months. The difference between these two is the measured energy savings for these projects.

Baseline Natural Gas Use

The monthly gas bills were reviewed and averaged for 3-1/2 years to determine the average or "baseline" gas use before the upgrades. The annual gas use from year to year does not vary by more than 5%. There

are larger variations that occur from month to month. These monthly variations are attributed to temporary changes in the use of the pool blankets, and temporary changes to the pool and space heating systems.

Table 2 lists the monthly gas use through the boiler room meter before the upgrade. Figure 3 graphs this monthly billed gas use. Figure 4 graphs the average monthly billed gas use over this time period, which is considered the baseline gas use for this article.

There is a noticeable increase in gas use over the winter months. This is attributed to lower indoor space humidity, which increases the water evaporation rates and water heating energy.

Table 2. Gas Use Prior to Upgrades

Month	*2003 Gas Use (billed therms)*	*2004 Gas Use (billed therms)*	*2005 Gas Use (billed therms)*	*2006 Gas Use (billed therms)*	*Average Gas Use Before Upgrade (billed therms)*
Jan	5,635	6,246	7,325	6,758	6,491
Feb	4,900	5,638	5,284	6,024	5,462
Mar	4,582	5,676	5,070	7,407	5,684
Apr	4,516	4,656	5,312	5,656	5,035
May	4,040	3,684	3,947	5,077	4,187
Jun	3,972	4,457	4,174	4,622	4,306
Jul	5,917	4,928	5,133	4,620	5,150
Aug	5,522	3,689	4,086		4,432
Sep	6,209	4,934	3,838		4,494
Oct	4,427	3,756	4,370		4,184
Nov	5,260	5,801	5,643		5,568
Dec	5,832	5,247	6,303		5,794
Totals	60,812	58,712	60,485	40,164	61,286

There is a slight increase in gas use over the summer months, particularly in 2003. This summer increase is attributed to the opening of the roof, which exposes the pool to cooler weather in the mornings & evenings (50°F to 60°F) and exposes the pool water to some wind. These two factors also increase the evaporation rate of the pool water.

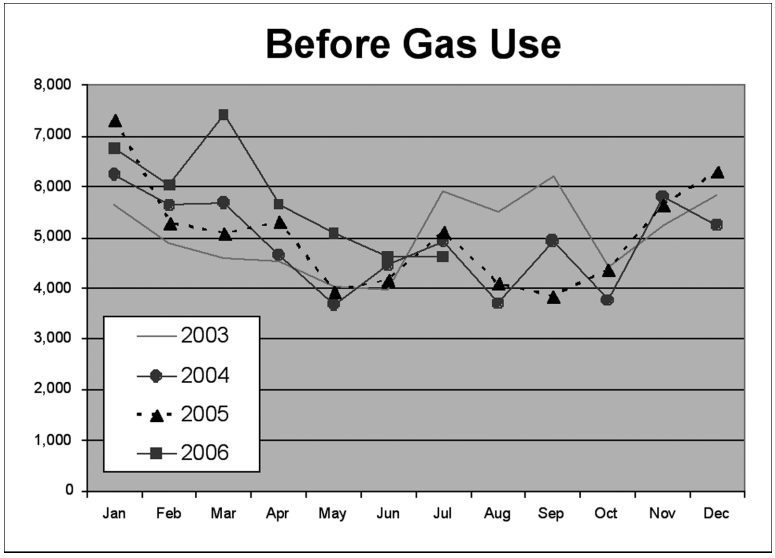

Figure 3. Gas Use Before Upgrades

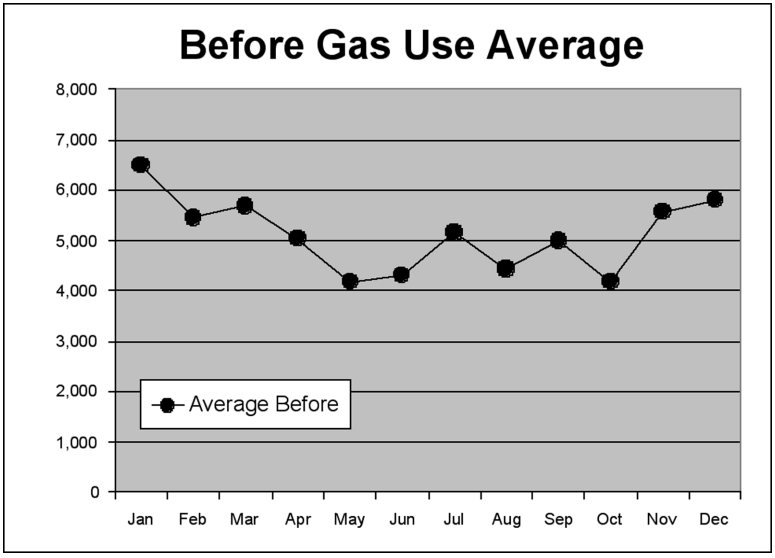

Figure 4. Average Baseline Gas Use

Post-Upgrade Natural Gas Use

The monthly gas bills since the construction was completed have been averaged to determine a "post-upgrade" average gas use. Table 3 lists the monthly gas use through the boiler room meter since the upgrade. Figure 5 graphs this monthly billed gas use. Figure 6 graphs the average monthly billed gas use over this time period, which is considered the post-upgrade gas use for this article. Table 4 lists the monthly gas use before and after the upgrades.

Table3. Gas Use After Upgrades

Month	*2006 (billed therms)*	*2007 (billed therms)*	*2008 (billed therms)*	*Average Gas Use After Upgrade (billed therms)*
Jan		6,662	5,216	5,939
Feb		4,597	4,804	4,701
Mar		4,195	4,140	4,168
Apr		3,487		3,487
May		3,366		3,366
Jun		2,940		2,940
Jul		3,189		3,189
Aug	2,996	3,288		3,142
Sep	2,288	2,069		2,178
Oct	1,799	3,379		2,589
Nov	4,008	3,868		3,938
Dec	5,041	4,628		4,835
Totals	16,132	45,667	14,161	44,471

Note: The January 2007 gas use was higher than expected because of the failure of the space heating system in the natatorium. This failure lowered the space temperature by 10 to 15°F, which increased the evaporation rate of the pool and the subsequent pool heating energy. This problem started in December 2006 and was repaired in February 2007. The savings for January 2008 have been in line with predictions.

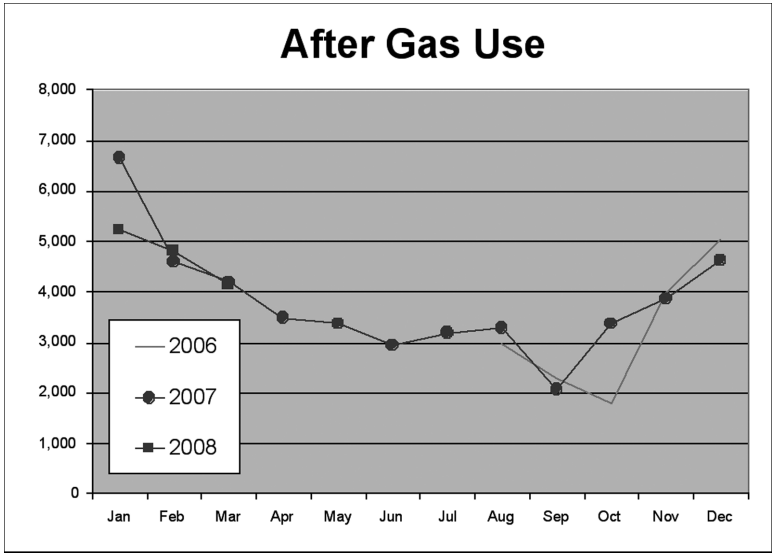

Figure 5. Gas Use After Upgrades

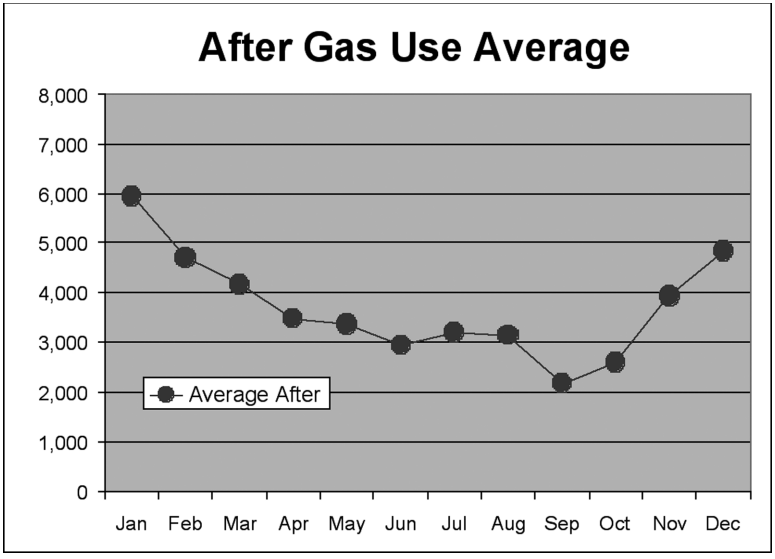

Figure 6. Average Gas Use After Upgrades

Table 4. Gas Use Before and After Upgrades

Month	2003 Gas Use (billed therms)	2004 Gas Use (billed therms)	2005 Gas Use (billed therms)	2006 Gas Use (billed therms)	2007 Gas Use (billed therms)	2008 Gas Use (billed therms)
Jan	5,635	6,246	7,325	6,758	6,662	5,216
Feb	4,900	5,638	5,284	6,024	4,597	4,804
Mar	4,582	5,676	5,070	7,407	4,195	4,140
Apr	4,516	4,656	5,312	5,656	3,487	
May	4,040	3,684	3,947	5,077	3,366	
Jun	3,972	4,457	4,174	4,622	2,940	
Jul	5,917	4,928	5,133	4,620	3,189	
Aug	5,522	3,689	4,086	2,996	3,288	
Sep	6,209	4,934	3,838	2,288	2,069	
Oct	4,427	3,756	4,370	1,799	3,379	
Nov	5,260	5,801	5,643	4,008	3,868	
Dec	5,832	5,247	6,303	5,041	4,628	
Totals	60,812	58,712	60,485	56,296	45,667	14,161

Note: Shaded area is after upgrades.

Resulting Measured Natural Gas Savings

The measured gas savings for these projects is 16,815 therms per year (27% of the baseline use) based upon the difference between the average gas bills before and after the upgrades. These measured savings are 10% higher than the 15,281 therms of annual savings that was predicted prior to the upgrade using RETScreen software and customized spreadsheet analysis (see Figure 7).

Table 5 lists the average baseline, post-upgrade and saved monthly gas use through the boiler room meter. Figures 8a and 8b show this data graphically.

SUMMARY AND CONCLUSION

The facility has lowered its natural gas costs by approximately $17,000 per year. This is a result of a boiler upgrade that saves 20% of

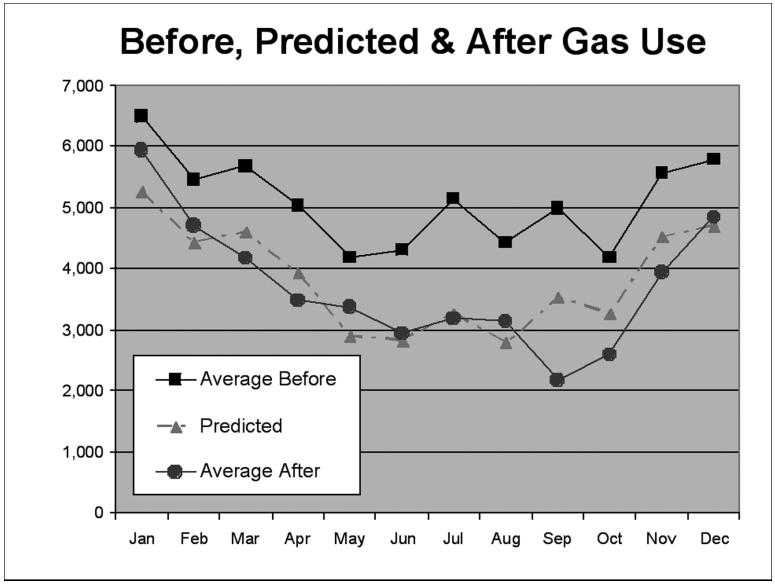

Figure 7. Actual Savings v. Predicted

Table 5. Before, After and Gas Savings

Month	*Average Gas Use Before Upgrade (billed therms)*	*Average Gas Use After Upgrade (billed therms)*	*Total Gas Savings (billed therms)*
Jan	6,491	5,939	552
Feb	5,462	4,701	761
Mar	5,684	4,168	1,516
Apr	5,035	3,487	1,548
May	4,187	3,366	821
Jun	4,306	2,940	1,366
Jul	5,150	3,189	1,961
Aug	4,432	3,142	1,290
Sep	4,494	2,178	2,815
Oct	4,184	2,589	1,595
Nov	5,568	3,938	1,630
Dec	5,794	4,835	960
Totals	61,286	44,471	16,815

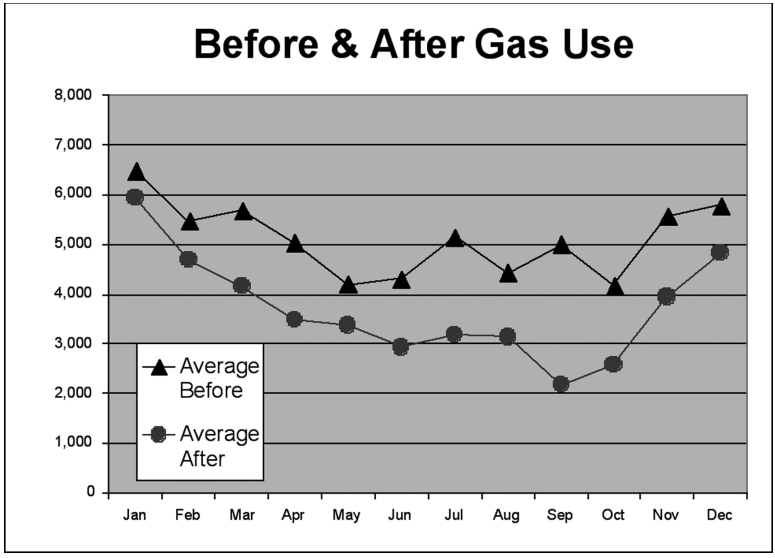

Figure 8a. Before and After Gas Use

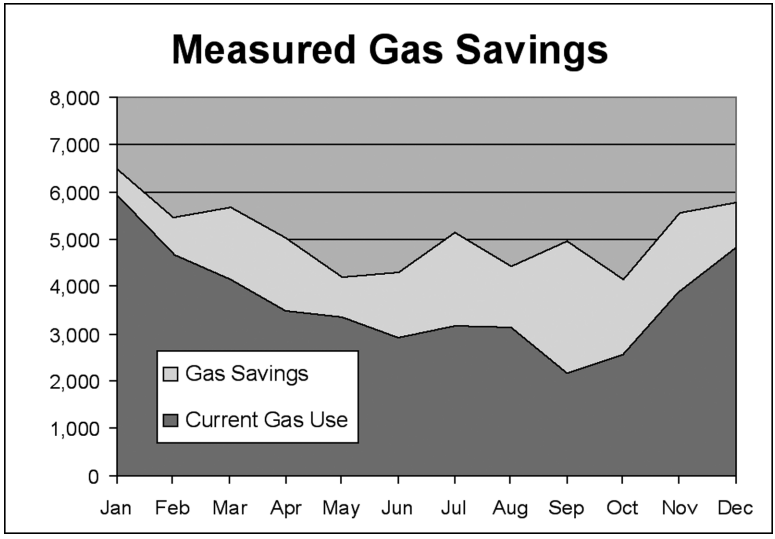

Figure 8b. Saved Gas Energy

the baseline use and a solar pool system that saves another 7%. These two measures will completely pay for themselves from the energy savings in 11 years, and both systems have a life expectancy of 20 years. The owner took advantage of tax credits to reduce the installation costs by 25% and utility incentives to reduce them by an additional 8%.

ABOUT THE AUTHOR

Richard W. Davis has been employed in the energy conservation field since 1990. He has performed energy audits at thousands of commercial, institutional and industrial sites. He has also been the project manager for energy conservation projects totaling $10 million dollars in construction costs. He received a BS in energy engineering technology from the Rochester Institute of Technology in 1990. Richard has been employed at Enertia Energy, Inc. in Beaverton, Oregon, since 2003. He can be reached at richd@enertiaenergy.com (503) 972-7808.