Solar Water Heating for Swimming Pools

Kathleen Harford and Arianna Netzky

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Introduction

Welcome to the Canyon Gate Country Club housing development in Middleton, Wisconsin. We are pleased and most excited that you have chosen to purchase your custom home in our neighborhood. As you begin your journey with one of our designers into making your house “your home”, we would like you to not only consider your family, but also your community and the environment.

As you have stated in your initial house planning design, you would like to have a swimming pool in your backyard. Wisconsin summers are something that we encourage your family to take advantage of, but without the extra cost of the environment. This is why we are proposing that you seriously consider a solar water heating system for your pool. The following

analysis will provide you with in depth information as to the benefits of choosing to heat your pool this way. We prefer Techno-Solis Swimmaster C20TS12, but feel free to look into other systems. However, we have a contract with Techno-Solis and all of our numbers will be based on this system.

Thank you for your consideration in this matter, and again, we look forward to your move into the Canyon Gate neighborhood.

Problem

As you know, the world's fossil fuel resource is depleting at an exponential rate and we need to start limiting our dependence on gas. The implementation of renewable energy sources in our everyday lives is extremely important: no matter how big or how small. You can make the biggest difference by being energy conscious with your home.

According to the U.S. Department of Energy, solar water heating for your pool is one of the most cost-effective ways of using solar power. In Madison, with a pool the size of 45 meters squared, you can use around 1100 meters cubed of natural gas annually. This will add around

$440 to your yearly heating bill and cost the environment unnecessary pollution and destruction. With a swimming pool solar water heater, you can prevent these extra costs and only use an extremely minimal amount of electricity. Another thing, by setting your initial water temperature a few degrees lower and using your pool cover, you can also conserve energy and lower your costs (that will be explained further in the analysis).

The system that we encourage is the Techno-Solis C20TS12. After conducting a price analysis on many solar water heating systems, we found that this one is the most efficient for the price. The company is based in Florida; however, we have set-up a contract with them so you won't have to pay outlandish shipping and handling fees along with the other hidden costs that go along with other companies. With that being said, the cost of the system by itself is $1862. After all installation, planning, and labor fees, the grand total of the system is $2982.

Also ,keep in mind that the numbers in this analysis are based upon the following monthly pool usage:

Month	Usage
May	50%
June	100%
July	100%
August	100%
September	50%

The lifespan of your Techno-Solis Swimmaster C20TS12 is at least twenty-five years, but its' "clean" energy use and extremely low impact on the environment will last for generations.

Technical Analysis

Your new Techno-Solis Swimmaster C20TS12 has two main components: the panels and the pump. With this system, you will have a 30 Watt pump. As for the panels, there will be six of them on the roof totaling an area of 26.6 meters squared. The panels will only be visible from your backyard, so that landscape and display of the front of the house will not be hindered. For more detailed size measurements, please refer to the table below.

Dimensions	C20TS12
Overall Length (Inches)	144.00
Absorber Width (Inches)	47.63
Header Length (Inches)	50.75
Header OD (Inches)	2.31
Header ID (Inches)	1.89
Gross Area (Square Feet)	47.725
Net Area (Square Feet)	47.625
Number of Flow Channels	104
Nominal Hole Size	.156

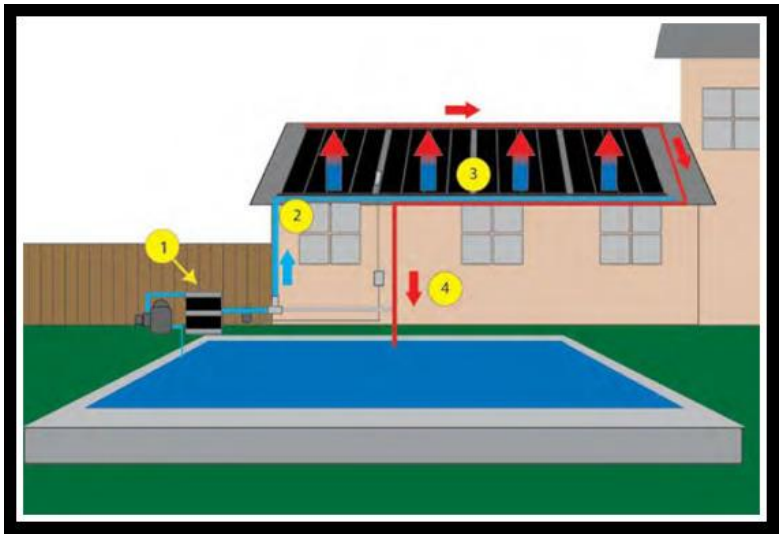
*information found on the Techno-Solis website

The power capacity of the system is 18.62 kW with an operational efficiency at 70%. The total power generated will be 1200 kWh annually. However, this will fluctuate with “not-so-sunny” weather (for safety reasons, hopefully you and your family won’t be using your pool in poor weather). In total, the heat that will be delivered is 1200 kWh annually.

Solar water heater				
Type	Unglazed			$ 1,862
Manufacturer	Techno-Solis			
Model	Swimmaster C20TS12			
Gross area per solar collector	m²	4.43		
Aperture area per solar collector	m²	4.43		
Fr (tau alpha) coefficient		0.82		
Wind correction for Fr (tau alpha)	s/m			
Fr UL coefficient	(W/m²)/°C	16.73		
Wind correction for Fr UL	(J/m³)/°C			
Number of collectors		6	1	
Solar collector area	m²	26.60		
Capacity	kW	18.62		
Miscellaneous losses	%	1.0%		
Balance of system & miscellaneous				
Heat exchanger	yes/no	No		
Miscellaneous losses	%	5.0%		
Pump power / solar collector area	W/m²	4.00		
Electricity rate	$/kWh	0.100		
Summary				
Electricity - pump	MWh	0.0		
Heating delivered	MWh	1.2		
Solar fraction	%	100%		

Living in the northern Midwest region, there tends to be a consistent amount of wind. This is one of the main problems with solar water heating for pools. Even if it is sunny outside, wind can sometimes affect the heating process because it cools down the flow tubes. However, the Techno-Solis system has a patented design that allows for connected insulated flow tubes which allow them to stay warm longer. This also benefits the system in the wintertime because it allows for expansion when frozen.

How it works:



As you can see from the picture, the solar water heating system is not too complicated. Initially, the pump sucks up the cool water from the pool and moves it to the collectors. The water is then heated as it flows upwards through the collector tubes. After that, the water travels back into the pool creating an overall higher water temperature. It does this until the desired water temperature is reached. The collectors are unglazed and will be set at a fixed twenty degree angle. You won't have to worry about any position angling because the installers will do that for you.

Because the whole idea of this system is to be energy efficient and cautious, we have set the temperature to 22 degrees Celsius (72 degrees Fahrenheit), which, according to RETScreen software, is the standard temperature of a competitive racing pool. If you decide that you would like your pool warmer, you can change the temperature. However; by doing this, your payback might take a little longer than projected. Included with this system is a pool cover, and we highly encourage you to keep this on when the pool is not in use as to conserve energy. We estimated a daily average of sixteen hours of cover use (there are days that you won't be using your pool, i.e. stormy weather, summer vacations, etc.). Understandably, this can be an

annoying chore; however, with leisure and luxury, there comes a price, and in the long run, it will save you a lot of time and money.

The Swimmaster C20TS12 is connected to your home's energy source, so you won't have to worry about any self-generating power sources or it not running (unless there is something malfunctioning or the power goes out). In other words, it is connected to the grid. The pump will provide 100% of your pool heating needs so it is important to take care of it. Luckily, solar water heaters require minimal maintenance. Every year, primarily right after the swimming season ends, you will want to check the drainage of the system before freezing occurs. Also during this annual inspection, you will want to check the level of the water/glycol mixture (the liquid used in water transfer). It usually needs to be replaced every four to seven years. That is as much maintenance as your solar water heater will need; simple as that.
As stated previously, the lifespan of your system is guaranteed for twenty-five years. Techno-Solis panels contain 35% more polypropylene and UV stabilizers than other panels on the market. This means that they will have a longer lifespan and withstand the strength of a 150 mph hurricane.

Environmental Analysis

The solar water heating system does not have much environmental impact at all. It may be necessary to cut down a few trees to eliminate shading in the area so that the solar panels can collect optimum solar energy, but there are not many in the development area. As stated before, the panels will be attached to the roof in the back of the house, and therefore will not affect the esthetics or property value of the home.

By using this solar water heating system we are saving a total of 85 percent of energy, which is very successful for a small scale project. This solar water heating system, with a project

lifespan of 25 years, has an estimated a fuel cost escalation rate of two percent and a discount rate of five percent which is typical for the return on a conservative, secured investment.

Proposed case system GHG summary (Heating project)

Fuel type	Fuel mix %	Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Solar	98.8%	1	0.000	0.0
Electricity	1.2%	0	0.472	0.0
Total	100.0%	1	0.006	0.0

Wisconsin is more dependent on importing fossil fuels than most other states, because it doesn't have a natural resource of oil, coal, natural gas, or uranium. By installing the solar water heating system our net GHG reduction is about two tons of carbon dioxide per year and 50 tons of carbon dioxide over the 25 year span of the project. We set our GHG reduction credit rate to be one dollar per ton of carbon dioxide reduced and since our project was small a GHG reduction credit escalation rate of one percent.

Economic Analysis

All input prices and miscellaneous costs for the solar heating system were taken from recommendations by the RETScreen user manual. According to the DSIRE website, solar water heating projects are not subject to property tax; therefore, the increase of the value of your house will not be subjugated. Our RETScreen analysis, consequently, did not include property

tax as a factor for total cost.

Initial costs (credits)	Unit	Quantity	Unit cost	Amount	Relative costs
Feasibility study					
Feasibility study	cost	0		$ -	
Sub-total:				**$ -**	0.0%
Development					
Development	cost	0		$ -	
Sub-total:				**$ -**	0.0%
Engineering					
Engineering	cost	2	$ 40	$ 80	
Sub-total:				**$ 80**	2.7%
Heating system					
Solar water heater				$ 1,862	
User-defined	cost	1	$ 420	$ 420	
		1	$ 40	$ 40	
Sub-total:				**$ 2,322**	77.9%
Balance of system & miscellaneous					
Spare parts	%	0.0%		$ -	
Transportation	project	1	$ 300	$ 300	
Training & commissioning	p-d	1	$ 40	$ 40	
User-defined	cost	4	$ 60	$ 240	
Contingencies	%	0.0%	$ 2,982	$ -	
Interest during construction		0 month(s)	$ 2,982	$ -	
Sub-total:				**$ 580**	19.5%
Total initial costs				**$ 2,982**	100.0%

After completing the economic analysis of the solar water heating system using method two, the system has an internal rate of return of 16.3% and an equity payback of 6.4 years. After researching solar water heating systems we had found that the average payback for a solar water heating pool system was anywhere from one to seven years, so this specific project seems feasible.

Annual costs (credits)	Unit	Quantity	Unit cost	Amount
O&M				
Parts & labour	project	0		$ -
User-defined	cost			$ -
Contingencies	%	0.0%	$ -	$ -
Sub-total:				**$ -**
Fuel cost - proposed case				
Electricity	MWh	0	$ 100.000	$ 2
Sub-total:				**$ 2**

Financial viability		
Pre-tax IRR - equity	%	16.3%
Pre-tax IRR - assets	%	16.3%
After-tax IRR - equity	%	16.3%
After-tax IRR - assets	%	16.3%
Simple payback	yr	6.9
Equity payback	yr	6.4
Net Present Value (NPV)	$	4,640
Annual life cycle savings	$/yr	329
Benefit-Cost (B-C) ratio		2.56
GHG reduction cost	$/tCO2	(163)

Project costs and savings/income summary			
Initial costs			
Engineering	2.7%	$	80
Heating system	77.9%	$	2,322
Balance of system & misc.	19.5%	$	580
Total initial costs	**100.0%**	**$**	**2,982**
Annual costs and debt payments			
O&M		$	0
Fuel cost - proposed case		$	2
Total annual costs		**$**	**2**
Periodic costs (credits)			
Annual savings and income			
Fuel cost - base case		$	435
GHG reduction income - 25 yrs		$	2
Total annual savings and income		**$**	**437**

We performed both a sensitivity and risk analysis on our heating project. The sensitivity analysis was performed on the equity payback of the project. We compared the initial cost, GHG reduction credit rate, and our fuel cost base case all to our fuel cost for the proposed case. We set our threshold to be seven years. Unless our fuel cost base case is in the lower ten

percent of our original estimation, our project has a good chance of paying itself in seven years or less. The risk analysis was performed on equity payback as well. Our range for initial cost and GHG reduction credit rate were ten percent, fuel cost(proposed and base case) were five percent, and net GHG reduction credit duration and debt term were zero percent. Our risk analysis claims that our initial cost and our fuel cost base case are the two factors that have the highest impact on our payback period. Other factors will not affect the payback period as greatly.

Sensitivity analysis

Perform analysis on	Equity payback	
Sensitivity range	10%	
Threshold	7	yr

Fuel cost - proposed case		Initial costs				$
		2,684	2,833	2,982	3,131	3,280
$		-10%	-5%	0%	5%	10%
1	-10%	5.8	6.1	6.4	6.7	7.0
1	-5%	5.8	6.1	6.4	6.7	7.0
2	0%	5.8	6.1	**6.4**	6.7	7.0
2	5%	5.8	6.1	6.4	6.7	7.0
2	10%	5.8	6.1	6.4	6.7	7.0

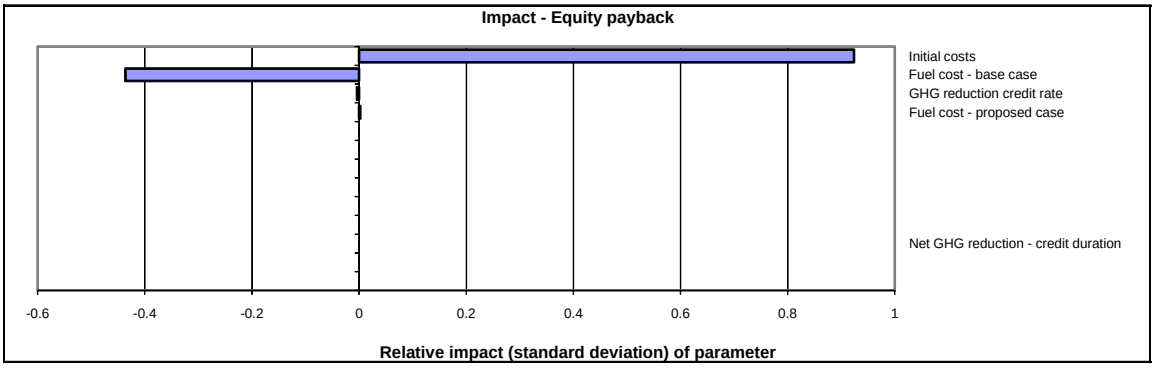
Fuel cost - proposed case		GHG reduction credit rate				$/tCO2
		0.90	0.95	1.00	1.05	1.10
$		-10%	-5%	0%	5%	10%
1	-10%	6.4	6.4	6.4	6.4	6.4
1	-5%	6.4	6.4	6.4	6.4	6.4
2	0%	6.4	6.4	**6.4**	6.4	6.4
2	5%	6.4	6.4	6.4	6.4	6.4
2	10%	6.4	6.4	6.4	6.4	6.4

Fuel cost - proposed case		Fuel cost - base case				$
		391	413	435	456	478
$		-10%	-5%	0%	5%	10%
1	-10%	7.0	6.7	6.4	6.1	5.8
1	-5%	7.0	6.7	6.4	6.1	5.8
2	0%	7.0	6.7	**6.4**	6.1	5.8
2	5%	7.0	6.7	6.4	6.1	5.8
2	10%	7.0	6.7	6.4	6.1	5.8

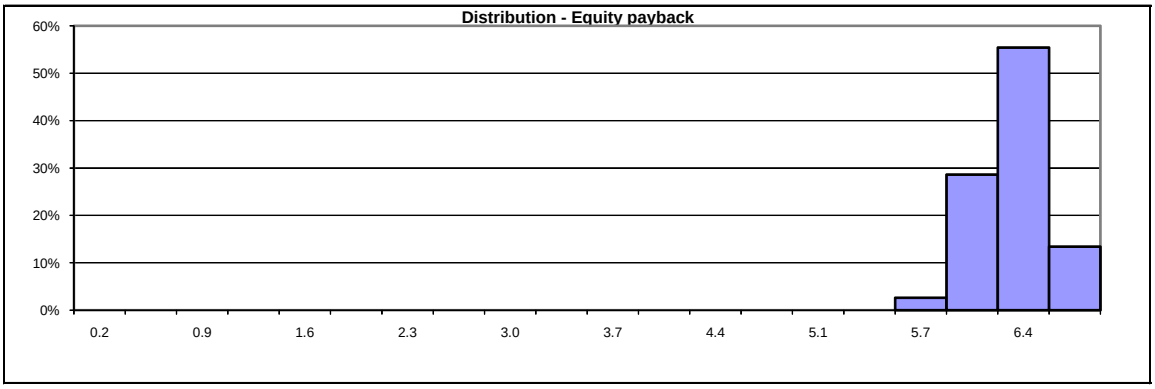
Risk analysis

Perform analysis on: Equity payback

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	2,982	10%	2,684	3,280
Fuel cost - proposed case	$	2	5%	1	2
Fuel cost - base case	$	435	5%	413	456
GHG reduction credit rate	$/tCO2	1.00	10%	0.90	1.10
Net GHG reduction - credit duration	tCO2	50	0%	50	50
Debt term	yr	0	0%	0	0



Median	yr	6.4
Level of risk	%	
Minimum within level of confidence	yr	0.1
Maximum within level of confidence	yr	7.0



Summary/Conclusion

RETScreen was, yet again, a very helpful tool when it came to understanding the "real-life" application of a renewable energy system. However, with stating that, both of us, again, had a hard time with the more advanced analysis/methods (i.e. method 2 and method 3). We found this project to be very interesting in a sense of how simple and inexpensive it can be for a swimming pool solar-water heater. I, Arianna, being from Las Vegas where almost one out of

three homes has a pool, found this project to be extremely fascinating. I, personally, don't understand why these systems aren't pushed more on pool owners. Clark County already implements regulations on water usage and air-conditioning units, so I don't see why these systems aren't highly encouraged, let alone advertised or persuaded. My father, who still lives in Las Vegas, has a pool at his five year-old house, and, honestly, I don't think he would have the slightest idea about solar-water heaters. The Kalahari Hotel in Wisconsin Dells uses a solar-hot water heater for their laundry, and the hotels in Las Vegas should use this as an example and take advantage of the 300+ days of sun a year. This would help out the environment exponentially. When we initially started this project, we had no idea of the low cost of these systems, or more in a sense of the quick payback. Both of us agree that when, or if, we ever get a pool, we will get a solar-water heater.

As in our first project, the analysis made the renewable energy system more applicable to our daily lives. We still wish that RETScreen was a little more user-friendly; however, we found no major weaknesses in the analysis. The project itself seems like a "no-brainer". Because the buyer is currently building a pool and doesn't have any sort of heating system for his/her pool to begin with, it should be completely obvious to choose the solar-water heating system. Even if the home-owner already has a heating system, I feel that we were able to provide enough solid information for the consumer to seriously consider, or even purchase, a swimming pool solar-heating system.

*All numerical data used in RETScreen analysis was suggested by the RETScreen etextbook for swimming pool solar-water heaters unless noted within the above analysis.
*All tables shown in project are from our RETScreen analysis unless otherwise noted.