

Using RETScreen for Solar Hot Water:

This pdf provides a step by step on how I used RETScreen to model the solar water heating system used for this method on how to size a DIY solar water heating system. Hopefully, this will make the RETScreen learning curve short for you.

Go to <http://www.retscreen.net/ang/home.php>

Download the RETScreen4 package.

This is an Excel spreadsheet and some other supporting documentation and sample project information.

Startup RETScreen, which will bring up RETScreen in Excel.

Note that I show the inputs I entered for the study I did. You will want to change some of them for your situation (eg location, number of occupants, ...)

On the “Start” or “Project Information” page:

Enter a project name, location, etc.

For “Project type”, select “Heating” from the drop down menu

Select “Technology”, select “Solar Water Heater”

For “Analysis Type”, select “Method 1”

For “Heating value ref”, select “Higher Heating Value HHV”

Select Climate data location: Pick the area you want

This loads in the Solar Hot Water template (RETScreen can do many types of analysis via different templates).

Click the Show settings checkbox

If you want US units, select “Imperial units” from the Units menu. The rest of this example is done with Imperial units.

Note that if you want to look at some filled in examples, click on the “See project database” at the top of the page, and pick an example project of interest.

The page should look like this:

Project information		See project database
Project name	Solar DIY	
Project location	US	
Prepared for		
Prepared by		
Project type	Heating	
Technology	Solar water heater	
Analysis type	Method 1	
Heating value reference	Higher heating value (HHV)	
Show settings	<input checked="" type="checkbox"/>	
Language - Langue	English - Anglais	
User manual	English - Anglais	
Currency	\$	
Units	Imperial units	
Site reference conditions		Select climate data location
Climate data location	Bozeman Gallatin Field	
Show data	<input type="checkbox"/>	

Now switch to the “Energy Model” page (click Energy Model tab at bottom of page)

Energy Model Worksheet:

Note that in many cases they ask for an input for a “Base case” and a “Proposed case”. The base case is your existing hot water system, and the proposed case is the new solar water heating system. You have to fill in inputs for both.

Load Characteristics: Hot Water

Load type: House

Occupants: number of people using hot water in your house (eg 3)

Daily Hot Water Use: gallons of hot water each person’s uses (eg 16 gal/day per person).

I used 3 occupants at 16 gallons per day each for a total of 48 gallons a day of hot water use.

Change water units to gal/day

Temperature: change temp units from C to F, enter your hot water temperature setting (eg 120F)

Op days/wk: 7

Water temp min: "formula" (it will estimate monthly ground water temps)

Water temp max (and min): use the values it supplies (based on your location) unless you know a better value.

Heating: incremental initial cost: 0

Solar tracking mode: fixed

Slope: the tilt of your collector from horizontal in degrees

Note: I set the slope equal to latitude for each city I looked at – this usually gives good year round performance.

Azimuth: set to the azimuth for your collector

Note: 0 is south (SW and SE are 45 deg, E and W are 90 deg). I set the azimuth to 0 for all cities I looked at.

If you check Show Data, it will show daily solar radiation on the collector by month.

Solar Water Heater

Type: Glazed (alternately pick unglazed or evacuated tube)

Cost (right hand box): enter your estimated cost of materials for the system.

Note: I used this equation to calculate the cost of the system:

$$\text{Cost} = (\$8.5)(\text{Collector area sqft}) + (\$1.80)(\text{Tank size gallons}) + (\$118 \text{ in plumbing}) + (\$207 \text{ in DWH preheat}) + (\$100 \text{ in controls})$$

So, you have to calculate and change the cost when collector size or tank size are changed.

These are DIY costs based on my [\\$2K installation](#) without the space heating feature.

Manufacturer and Model: enter whatever you like

Gross area per collector: change units to sf, enter collector gross area in sqft

Aperture area: change units to sf, enter 0.9*gross area above

Note: I assume that the aperture area is 90% of the gross area.

Fr coefficient: 0.73 (Heliodyne black paint absorber)

Fr UL: change to coefficient BTU/sf-F, enter 1.07

Note: The two values above define the efficiency curve of the collector. I use the efficiency parameters from the SRCC testing of the Heliodyne Gobi black painted absorber test – this should be close to what a good DIY collector will achieve.

Temperature coefficient: 0 (for linear efficiency curve)

Number of collectors: 1

Capacity: RETScreen's estimate of collector output in KW

Misc losses: 3% for losses due to snow and dirt.

Balance of System and Misc

Storage: yes

Storage capacity / sf of collector: change unit to gal/sf, enter 2.5

Note: I used 2.5 gallons of storage per sqft of collector – you can experiment with other values. RETScreen will round the 2.5 to 3 in the display, but the 2.5 is used for calculations.

Storage Capacity: RETScreen's calculation of storage tank size.

Note that RETScreen uses **aperture** area * Storage cap/sf you entered (not the gross area).

Heat Exchanger: No

Note: for the type of drain back system we use, this heat exchanger is not used.

Misc Losses: 3%

This covers heat loss from tank and plumbing.

Pump power: change units to W/sqft, enter 1 watt/sqft

Note: This is the number of watts per sqft of collector area the pump is assumed to use.

Electricity rate: \$0.12 /KWH (or whatever you pay)

Summary

Electricity pump: RETScreen 's estimate of pump energy use

Heat Delivered: RETScreen's estimate of yearly system heat output in million BTU.

Solar Fraction: RETScreen's estimate of the fraction of your water heating needs provided by solar.

Heating System

These inputs define your backup system for heating water when there is not enough sun. I use a standard electric hot water tank at 90% efficiency.

Fuel type: Electricity on both Base and Proposed cases

Seasonal Efficiency: 90%

Note: this is the efficiency of the current hot water system for the base case, and of the backup water heating system for the proposed case.

Fuel Consumption – RETScreen's estimate of fuel used before and after solar in mega watt hours (these numbers determine solar fraction).

Fuel Rate: enter your cost per KWH of electricity (eg 0.12 \$ per KWH).

Fuel cost: RETScreen's estimate of the cost of the fuel consumed (cost saving per year is the difference between the Base and Proposed cases)

Emissions Analysis

Country: enter your country (eg US), pick fuel by which your electricity is generated (eg coal).

T&D losses is a factor to cover energy loss in electricity transmission (eg 8%)

GHG Emissions:

Base case: RETScreen's estimate of emissions before solar hot water in tonnes of CO2

Proposed case: RETScreen's estimate of emissions after solar hot water in tonnes of CO2

Note: a tonne (or metric ton) is 2200 lbs (1000 kg).

Gross annual GHG emissions reduction: RETScreen's estimate of reduction in CO2 emissions for the system in tonnes.

Financial Analysis:

Inflation rate: enter estimated inflation rate (eg 3%)

Project life: enter anticipated project life (eg 25 years)

Initial Costs: enter the cost as calculated above (eg \$1250)

Heating system: \$1250 (total cost of system)

Other: enter 0 (these are additional costs to bring the project up – normally 0 for DIY project)

Incentives and grants: enter any tax breaks or grants you get here.

O and M cost or savings: enter 0 (I guess)

Fuel cost base case: cost of fuel before solar

Financial Viability:

Pre tax IRR: RETScreen's estimate of Internal Rate of Return

Simple Payback: RETScreen's estimate of the time in years for the savings to pay for the system.

Equity Payback: RETScreen's estimate of equity payback.

See below for a filled out "Energy Model" page

Save your work:

Use the File menu to save. You are offered as choice of saving as an Excel file, which saves the whole model in a regular (and rather large) Excel file. The other choice is to save as a .ret file, which RETScreen can open. To open a saved .ret file, double click on it, this will bring up a list of "user defined" saved files, pick the one you want and double click on it.

RETScreen Energy Model - Heating project

Heating project

Technology **Solar water heater**

Load characteristics

Application Swimming pool Hot water

	Unit	Base case	Proposed case
Load type		House	
Number of units	Occupant	3	
Occupancy rate	%	100%	
Daily hot water use - estimated	gal/d	48	
Daily hot water use	gal/d	48	48
Temperature	°F	120	120
Operating days per week	d	7	7

Percent of month used

Supply temperature method		Formula
Water temperature - minimum	°F	34.5
Water temperature - maximum	°F	51.1

	Unit	Base case	Proposed case	Energy saved	Incremental initial costs
Heating	million Btu	11.4	11.4	0%	\$ -

Resource assessment

Solar tracking mode		Fixed
Slope	°	45.0
Azimuth	°	0.0

Show data

Solar water heater

Type	Glazed		\$ 1,250
Manufacturer	DIY		
Model	cpr-alum		
Gross area per solar collector	ft²	65.00	
Aperture area per solar collector	ft²	60.00	
Fr (tau alpha) coefficient		0.69	
Fr UL coefficient	(Btu/h)/ft²°F	1.07	
Temperature coefficient for Fr UL	W/(m - °C)²	0.000	
Number of collectors		1	1
Solar collector area	ft²	65.00	
Capacity	kW	3.90	
Miscellaneous losses	%	3.0%	

Balance of system & miscellaneous

Storage		Yes
Storage capacity / solar collector area	gal/ft²	3
Storage capacity	gal	150.0
Heat exchanger	yes/no	No
Miscellaneous losses	%	3.0%
Pump power / solar collector area	W/ft²	1.00
Electricity rate	\$/kWh	0.120

Summary		
Electricity - pump	MWh	0.1
Heating delivered	million Btu	8.6
Solar fraction	%	76%

Heating system			Base case	Proposed case	
<input type="checkbox"/> Project verification					
Fuel type			Electricity	Electricity	
Seasonal efficiency			90%	90%	
Fuel consumption - annual	MWh		3.7	0.9	MWh
Fuel rate	\$/kWh		0.120	0.120	\$/kWh
Fuel cost	\$		444	107	

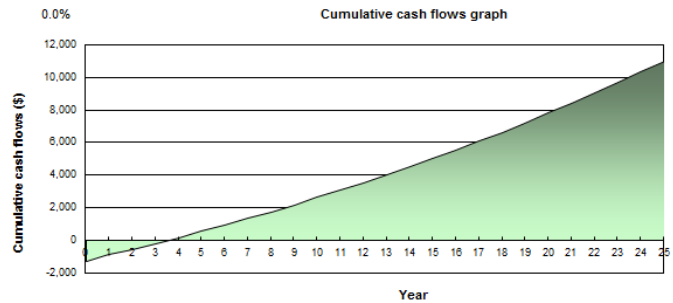
Emission Analysis

Base case electricity system (Baseline)	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
Country - region				
United States of America	Coal	0.907	8.0%	0.986

GHG emission				
Base case	tCO2	3.6		
Proposed case	tCO2	1.0		
Gross annual GHG emission reduction	tCO2	2.7		
GHG credits transaction fee	%	0.0%		
Net annual GHG emission reduction	tCO2	2.7	is equivalent to	0.5 Cars & light trucks not used
GHG reduction income				
GHG reduction credit rate	\$/tCO2	0.00		

Financial Analysis

Financial parameters		
Inflation rate	%	3.0%
Project life	yr	25
Debt ratio	%	0%
Initial costs		
Heating system	\$	1,250
Other	\$	0
Total initial costs	\$	1,250
Incentives and grants		
	\$	0
Annual costs and debt payments		
O&M (savings) costs	\$	
Fuel cost - proposed case	\$	118
Other	\$	
Total annual costs	\$	118
Annual savings and income		
Fuel cost - base case	\$	444
Other	\$	
Total annual savings and income	\$	444
Financial viability		
Pre-tax IRR - assets	%	29.8%
Simple payback	yr	3.8
Equity payback	yr	3.6



Gary

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