

RETScreen 4 User Manual for Public Outdoor Swimming Pools

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A. Introduction

This abridged manual has been created to walk you through the step-by-step process of filling out the information needed to perform a solar thermal heating feasibility test for your public swimming pool. The construction of this manual was prompted by the interest in clean energy heating expressed by Southwest Minnesota community pools and recreation centers. By the end of this project, you will be able to determine if solar thermal energy is practicable for your public pool. It is important to remember that the installation of a solar heating system will be supplementary to the primary heating system. Many numbers that are more general will be provided for you. You do not need to use these specific numbers, but they may be helpful to you. Words that are bolded are used to refer to specific labels and quotes on the program.

The programs required to run RETScreen on your computer include Microsoft Excel 2000 or higher, Microsoft Windows 2000 or higher, and Microsoft .NET Framework 4 or higher. RETScreen is a very large program and may take several minutes to download from the site.

Before beginning this assessment, go to the internet link: <http://solar.maps.umn.edu/>. It is a large solar analysis map. Type the address of your facility into the search bar. If the rooftop/clearing that you plan to put the solar panels on appears bright yellow to white, the area is very good for solar technology (up to 3.5 kW/m²). If the area appears black, it is not very good for solar technology (as little as 0.0 kW/m²). If this is the case, you will want to reassess the placement of your solar panels.

This program is designed to be used in the METRIC SYSTEM. It is highly recommended that you convert your units to metric and not enter them in the Imperial System, even though there is an option to do so. Using Imperial units will result in having to do many complicated calculations and conversions in order to complete the assessment.

If you have any questions about what a certain term or figure means, click on the box that the term is in and then click on the **Help** button, in the upper left corner of the tab. It is located under the **RETScreen** tab at the top of the page. This will give you an explanation or definition of a term you may be confused by.

B. Downloading RETScreen 4

1. Open an internet browser and go to the following site: <http://www.retscreen.net/eng/home.php>. In the middle of the page, you will see click on an underlined sentence that says **Click here to download RETScreen Suite**. The program is run through Microsoft Excel and will download two separate programs to your computer. The

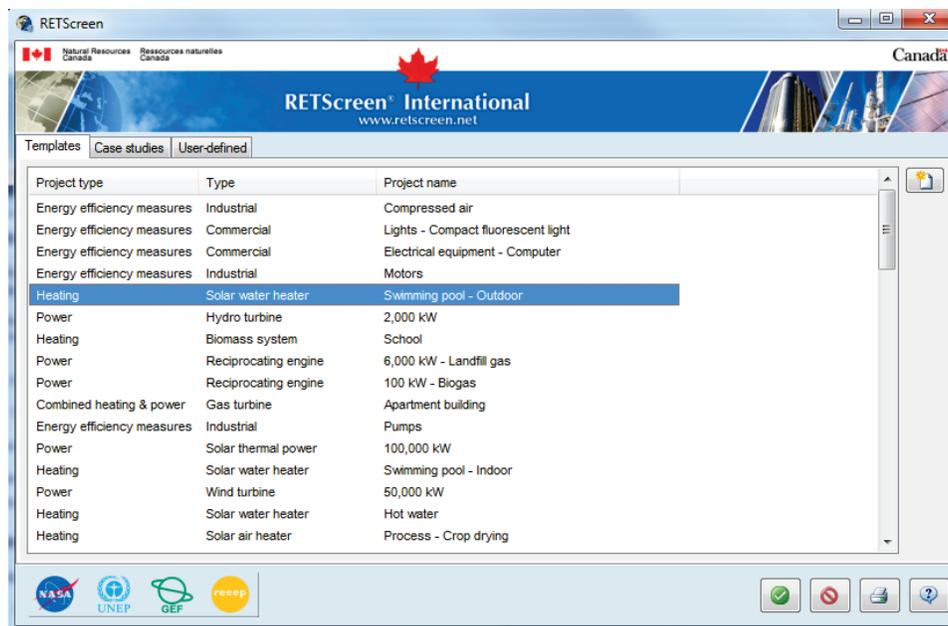
first is **RETScreen 4** and the second is **RETScreen Plus**. You will be using **RETScreen 4**, NOT **RETScreen Plus**. Recall that the downloading process may take several minutes.

2. The icon for **RETScreen 4** should have appeared on your desktop, where you can double click to open it. If it is not on your desktop, open up the “Downloads” folder of your computer and it should be the most recent item downloaded. The icon will look like this:



C. Filling Out Basic Project Information

1. After opening the program, Microsoft Excel opens a spreadsheet that will say **RETScreen International Clean Energy Project Analysis Software**. There will be two short sections titled **Project information** and **Site reference conditions**.
2. The first request under **Project information** is the **Project name**. For this, click on the blue underlined text that says, [See project database](#). A list of project types and names will pop up in a separate window. The one that you will want to select will be the fifth choice down from the top, which has the **Project type: Heating, Type: Solar water heater, and Project name: Swimming pool – Outdoor**. This setting will predetermine some of the information for you. The picture below shows you what the window will look like:



All of the boxes that are colored yellow do not need to be changed. You will want to change the **Project location** in the second box to your town and state. (i.e. Morris, Minnesota)

- Now that the **Project information** section is done, you will move on to the **Site reference conditions**. You will need to select the blue underlined text that says, [Select climate data location](#). A separate window will pop up. At the top of this window, click on the little arrow on the side of the first yellow box select your **Country – region** (presumably United States of America). Just underneath that, select your **Province / State** (presumably Minnesota). For the box labeled **Climate location data**, choose the city or town in which your pool is located. If your city or town is not provided on the list, choose the geographically closest possible city or town offered in the list of those given. The program will now create predetermined statistics about the climate based on your geographic location. Click the green check mark at the bottom of the page to complete the **Site reference conditions**. If the town we were using was Morris, MN, the end product would look like this:

Country - region: United States of America
 Province / State: Minnesota
 Climate data location: Morris Muni (AWOS)

Latitude: 45.7 °N
 Longitude: -96.0 °E
 Elevation: 347 m
 Heating design temperature: -25.1 °C
 Cooling design temperature: 29.3 °C
 Earth temperature amplitude: 25.8 °C

	Air temperature °C	Relative humidity %	Daily solar radiation - horizontal kWh/m ² /d	Atmospheric pressure kPa	Wind speed m/s	Earth temperature °C	Heating degree-days °C-d	Cooling degree-days °C-d
Jan	-11.9	84.3%	1.30	97.4	5.1	-12.8	927	0
Feb	-8.6	84.7%	2.16	97.4	5.1	-9.6	745	0
Mar	-2.4	82.5%	3.38	97.3	5.3	-2.6	632	0
Apr	6.6	72.2%	4.87	97.0	5.4	7.4	342	0
May	13.1	70.6%	5.48	97.0	5.5	15.3	152	96
Jun	19.0	74.1%	6.04	97.0	4.5	20.1	0	270
Jul	20.8	82.1%	6.36	97.1	3.6	22.3	0	335
Aug	19.5	83.2%	5.46	97.2	3.6	20.8	0	295
Sep	15.0	76.0%	4.17	97.2	4.3	15.2	90	150
Oct	7.6	74.0%	2.49	97.2	4.9	7.5	322	0
Nov	-1.1	81.8%	1.49	97.2	4.9	-2.4	573	0
Dec	-7.8	84.9%	1.07	97.4	5.1	-10.2	800	0
Annual	5.9	79.2%	3.70	97.2	4.8	6.0	4,583	1,145
Source	Ground	Ground	Ground	NASA	Ground	NASA	Ground	Ground

Measured at: m, 10, 0

- Once you have completed these tasks, you can now click on the underlined blue sentence that states, [Complete Energy Model sheet](#).

D. Energy Model Sheet: Heating project

- Before you begin filling out the Energy Model sheet, observe that in the lower left hand side of the spreadsheet there are three tabs: **Start**, **Energy Model**, and **Tools**. We will not be using the **Tools** tab. If you wish to change any basic information that you have entered, click on the **Start** tab to go back to the previous page.

RETScreen Energy Model - Heating project

Heating project

Technology: Solar water heater

Load characteristics

Application:

- Swimming pool
- Hot water

Unit	Base case	Proposed case
Type	Outdoor	
Area	400.0	400.0
Cover use	14.0	14.0
Temperature	25.0	25.0
Makeup water	25%	25%
Wind sheltering - season of use	20%	20%
Solar shading - season of use	20%	20%

Percent of month used

Month	Base case	Proposed case
January		
February		
March		
April		
May	25%	25%
June	100%	100%
July	100%	100%
August	100%	100%
September	25%	25%
October		
November		
December		

Supply temperature method: Formula

Water temperature - minimum: 1.0 °C

Water temperature - maximum: 11.1 °C

Unit	Base case	Proposed case	Energy saved	Incremental initial costs	
Heating	MWh	113.9	113.9	0%	

Resource assessment

Solar tracking mode: Fixed

Slope: 25.0 °

Azimuth: 0.0 °

Show data

Start **Energy Model** Tools

READY

Again, this program is designed to work in the METRIC SYSTEM. Changing your units to the Imperial System will require many difficult calculations and is not recommended, as RETScreen does not convert units for you. Converting the Imperial units to Metric units will save time and effort, though you will not need to do so frequently. The only conversions you will need are below:

1 foot = 0.3048 meters

Temp $(C) = (F - 32) \cdot \frac{5}{9}$ °C

- At the top of the page, there are two columns that are split into **Base case** and **Proposed case**. RETScreen has already filled in some of these numbers for you, though you will be changing some of them. You will use the **Base case** column to enter the figures for your current swimming pool statistics. You will use the **Proposed case** column for the swimming pool statistics you desire for your project. It is possible that you do not wish to change your statistics in terms of temperature, pool area, cover use, etc. If this is the case, fill in the same numbers for both columns. An image below displays the different columns:

Heating project		Solar water heater	
Technology			
Load characteristics			
Application	<input type="radio"/> Swimming pool <input type="radio"/> Hot water		
Type	Unit	Base case	Proposed case
Area	m ²	400.0	400.0
Cover use	h/d	14.0	14.0
Temperature	°C	25.0	25.0
Makeup water	%/w	25%	25%
Wind sheltering - season of use	%	20%	20%
Solar shading - season of use	%	20%	20%
<input checked="" type="checkbox"/> Percent of month used	Month		
	January		
	February		
	March		
	April		
	May	25%	25%
	June	100%	100%
	July	100%	100%
	August	100%	100%
	September	25%	25%
	October		
	November		
	December		

- Proceed to fill in the **Area** of your pool, the hours per day for **Cover use**, and the **Temperature** by clicking on the yellow boxes and typing in a number. If a cover is not used, enter 0. Keep in mind that cover use makes a very large difference in the end costs. For **Makeup water**, if you use a pool cover, the percentage will go up. The more you use the cover, the lower the percentage will be. If you use the cover for around 16 hours, the percentage will be around 20%. You can make an educated estimate here for your percentage. For **Wind sheltering**, you may want to consider how much foliage/blockage you have around your pool. If your pool is sheltered by bushes or a solid fence, your percentage of sheltering would be higher. If you have very little blockage, your percentage of sheltering would be lower. This figure is estimated based on your case. The same idea can be applied to the **Solar shading** row, in which you factor in how much shade there is over your pool. If there is nothing to shade the pool at any hour of the day, your solar shading percentage would be close to 0%. If you have lots of trees, buildings, or a pool cover shading your pool for much of the day, your solar shading percentage would be much higher. Again, this too is an estimated figure. Try as best you can to make the numbers in both the **Base case** and the **Proposed case** equal to each other, unless you are making large changes to your future system.
- On the left just under the previous information, there should be a small box next to the phrase **Percent of month used**. If that box is not already checked, click on it. Two columns with the months of the years will appear, again corresponding to the **Base case** and the **Proposed case**. This column represents how much of the year your pool is in use. RETScreen may have included some numbers, which you are welcome to use if they seem accurate for your pool. For June, July, and August, your pool use would most likely be at 100% because the pool is constantly in use. For some of the spring or fall months, the percentage may vary due to the time of the year that you open or close your pool. For example, if you open your pool in the middle of May, enter 50% in the row that corresponds

to the month of May. Any months in which your pool is not open you can leave blank. Keep in mind that the percentage of the number of months makes a very large cost difference in heating. You will want to choose these numbers carefully.

5. For the rows beneath labeled **Supply temperature method**, **Water temperature – minimum**, and **Water temperature – maximum**, the formula option should work just fine. However, if you have other values that you would like to include instead of the numbers provided by RETScreen, click on the yellow **Formula** box to change the setting to **User-defined**. You can do this by clicking on the box and then on the arrow to the right, like this:



6. **Incremental initial costs** will only be useful to you if you are purchasing a new heater or physically changing something about your initial system, not including adding solar collectors. This number will merely be added to your total cost at the end of the assessment. If you have a precise or estimated dollar amount, enter it in the yellow box. If you do not anticipate changing anything about the initial system, leave the box blank.
7. The **Resource assessment** row has three different sections: **Solar tracking mode**, **Slope**, and **Azimuth**. These refer to the solar collectors you will be installing. We will review these terms in order.
 - a. **Solar tracking mode** — There are four options for this box: **Fixed**, **One-axis**, **Two-axis**, and **Azimuth**. If you are placing the solar collectors on the roof of your facility, you will most likely choose **Fixed**. These collectors are entirely stationary and are the cheapest option. Almost all situations will use **Fixed** collectors, but in case you are looking into a setting that allows the panel to move, the other options will be described. **One-axis** collectors can move to follow the sun by pivoting on one axis with a north-south or east-west orientation. These are more feasible if your collectors are on the ground. The same guideline applies for **Two-axis** collectors, which can follow the sun on two axes and collect even more sunlight. **Azimuth** collectors have a fixed slope but rotate on a vertical axis, rather than a horizontal axis like the other two collector types.
 - b. **Slope** — For summer pool heating, the slope of a fixed collector should equal 10 to 15 degrees subtracted from the latitude of your location. RETScreen may have already entered a number that is pretty close to the number you've calculated. You may choose to change it if the number you calculate is not very close to RETScreen's estimation. A **Two-axis** collector will not have a slope; therefore the box should remain empty. In this case, do not type 0.0 into the box. Simply delete the number inside of it.

c. **Azimuth** — A collector that is facing the equator will have an azimuth of 0 degrees. If you are unsure about this figure, just enter 0.0 into the box in the assumption that your collectors will face due south.

8. We have now come to the **Solar water heater** section of the energy model sheet. For this section, we will use a model solar collector to generate accurate numbers for the assessment. This will be separated into different steps for you to follow.

a. **Type** — You will click on the yellow box and then click the arrow to the right. From here, you can scroll down and select **Unglazed**, if it is not already chosen for you.

***Note: The **Type** refers to the type of solar collector you would like to use. This includes **Unglazed**, **Glazed**, **Evacuated**, and **Other**. If you are in the northern hemisphere and plan on only heating your pools during the summer, **Unglazed** collectors are the cheapest and most efficient option here. These are not cold-resistant. If you plan on warming your indoor water system over the winter, **Glazed** collectors will work better and are cold-resistant. **Evacuated** collectors use a vacuum system and are sometimes used in colder climates, but are less common. They are cold-resistant. **Other** pertains to any other type of solar collector you may be thinking of using. Only enter **Other** if you have a specific model in mind that is not one of the above models. If you are unsure which you would like to use, **Unglazed** will be the best estimate if you are planning to heat your summer outdoor pool. This example is based on the case of **Unglazed** collectors. If you wish to use a different kind of collector for your pool, click the button that says **Product database** in the upper left corner of the screen. Here, you can choose what type of solar collector you would like and fill the information into the boxes below.

b. **Manufacturer** and **Model** — The **Manufacturer** and **Model** will be determined for you in this example. In the **Manufacturer** box, type “Aquatherm Industries”. In the **Model** box, type **Solar Industries 10001**. If you are not using the example and have a model of your own that you would like to try, be aware that the numbers in the next several steps (c. through g.) will be changed for you. In this case, DO NOT enter the numbers that have been provided in this manual and leave the numbers that RETScreen gives you as is. Only proceed to steps c. through g. if you are using the example that is provided by this manual.

c. **Gross area per solar collector** and **Aperture area per solar collector** — The **Gross area per solar collector** is the surface area of the collector. For this example, enter 4.35 in the blue box. The **Aperture area per solar collector** is the area of the collector that will absorb sunlight. For this blue box, enter 4.35.

d. **Fr (tau alpha) coefficient** — For the example provided, enter 0.76 in the blue box.

- e. **Wind correction for Fr (tau alpha)** — For the example provided, enter 0.04 in the blue box.
- f. **Fr UL coefficient** — For the example provided, enter 12.36 in the blue box.
- g. **Wind correction for Fr UL** — For the example provided, enter 9.00 in the blue box.
- h. **Number of collectors** — The **Number of collectors** refers to how many collectors you plan on installing at your facility. If you already know the number of collectors you want, enter that number. If not, start with the RETScreen suggestion (ex: 20 collectors) and scroll down to look at the cost and savings annually in the **Financial Analysis** section. Add or subtract collectors from the **Number of collectors** until a desired price and savings is reached. This number will be the recommended number of solar collectors for your facility. The maximum number of solar collectors you can install may have an area equal to the area of your pool. Remember that more collectors = more energy saved = more expensive to install.
- i. **Miscellaneous losses** — You may enter 3.0% in this box, if RETScreen has not done so already.

If you used the example provided, the end product should look similar to this. You may have a different **Number of collectors**, which means that the total installation price in the upper right corner may differ from this image:

Solar water heater			
Type	Unglazed		\$ 10,440
Manufacturer	AquaTherm Industries		
Model	Solar Industries 10001		
Gross area per solar collector	m ²	4.35	
Aperture area per solar collector	m ²	4.35	
Fr (tau alpha) coefficient		0.76	
Wind correction for Fr (tau alpha)	s/m	0.04	
Fr UL coefficient	(W/m ²)°C	12.36	
Wind correction for Fr UL	(J/m ²)°C	9.00	
Number of collectors		20	66
Solar collector area	m ²	87.00	
Capacity	kW	60.90	
Miscellaneous losses	%	3.0%	

9. We have now come to the **Balance of system & miscellaneous** section of the energy model sheet. This will be separated into different steps for you to follow.

- a. **Heat exchanger** — If you are installing unglazed solar collectors, you will most likely not use a **Heat exchanger**. Or, if the pool water will be pumped through the solar collectors, there will be no **Heat exchanger**. In this case, you may choose “no”. If you plan to run your pool throughout the winter or use the solar collectors for indoor water resources,

you will most likely use a **Heat exchanger**. Or, if the water in the collectors is separate from the pool water (i.e. the use of anti-freeze or collectors that cannot hold chlorine), you will use a **Heat exchanger**. In this case, you may choose “yes”. If “yes” is chosen, you must provide the **Heat exchanger efficiency**. This number is typically between 50% and 85%. 80% is the recommended entry if you are unsure of your heat exchanger’s efficiency.

- b. **Miscellaneous losses** — You may enter 4.0% in this box if RETScreen has not done so already. This will just be an estimate.
- c. **Pump power / solar collector area** — You may enter 5.00 in this box if RETScreen has not done so already. This will just be an estimate.
- d. **Electricity rate** — For this number, enter the amount of money your community pool spends on electricity in the unit of dollars per kilowatt/hour. It is likely that this figure is recorded on an electrical bill that you have received in the recent past. It is best to use that number if you can attain it, as small differences in the number can make a large difference in the final budget. You may enter 0.087 in this box if you do not know how much you pay for electricity at your community pool.

10. We have now come to the **Heating system** section of the energy model sheet. This will be separated into different steps for you to follow.

- a. **Fuel type** — For the **Base case** column, click on the box and the arrow to the right to choose the correct type of fuel. Do the same for the **Proposed case**. If you plan on using the same fuel, enter the same answer. If you are changing the type of fuel you will be using after installation, scroll through the list to find it. Most pools use natural gas, so that will be the most likely choice. If you use natural gas for your heating system, choose **Natural gas - therm**. If you use propane, choose **Propane - gal**.
- b. **Seasonal efficiency** — The **Seasonal efficiency** is the efficiency of the heating system. It is the ratio of output energy to input energy. Energy.gov gives an example where a heater uses \$80 worth of useful heat for every \$100 worth of fuel. This means that the heater wastes 20% of the fuel and is considered an 80%-efficient heater. If you are unsure of the ratio used heat to input energy, type 70 into the box. If you know the efficiency, type it into the box as a percentage. If you are purchasing a new heater, find the new efficiency and enter it under the **Proposed case** column. Your original heater’s efficiency will be entered under the **Base case** column. If you are not replacing your heater, the number in both case columns can remain the same. To the right of the efficiency boxes for both cases, there is an empty yellow box. If you are purchasing a new heater with a different efficiency, you can enter the price to get that new efficiency here.

- c. **Fuel rate** — This number will be how much money you pay for heater fuel per unit. You should have already chosen your fuel in the section Fuel type. For one therm, the cost is around 75 cents. Enter 0.75. If you are using a different fuel, such as propane, look up how much money it costs per gallon and enter that number into the box.

E. Energy Model Sheet: Emission Analysis

1. The **Base case electricity system (Baseline)** is not mandatory for knowing the price of the installation and annual costs, but provides a decent estimate on how much GHG (greenhouse gas) will be emitted. You may leave this whole section blank if you desire.
 - a. **Country** — The current country listed may be “Canada”. Click on the yellow box and then click the arrow just to the right in order to scroll down and select “United States of America”.
 - b. **Fuel type** — For **Fuel type**, click on the yellow box and then on the arrow to the right to scroll down to the type of fuel your facility will use. The most common choice is “Natural Gas”.
 - c. **GHG emission factor (excl. T&D)** — RETScreen will have entered this number for you. Do not change it.
 - d. **T&D losses** — RETScreen will have entered this number for you. Do not change it.
 - e. **GHG credits transaction fee** — Leave this blank, as it is nonexistent in the USA.
 - f. **GHG reduction credit rate** — Leave this blank, as it is nonexistent in the USA.

F. Energy Model Sheet: Financial Analysis

1. The **Financial parameters** section will cover Inflation rate, Project life, and Debt ratio.
 - a. **Inflation rate** — A safe estimate for this number is 2.0. If you have an estimate that you would like to use instead, enter that into the yellow box.
 - b. **Project life** — The **Project life** is the number of years that the system will be expected to last. While solar thermal systems are known to last for 40 years or longer, the number that you enter into the box will be 20. 20 years is the general minimum number of years that a system will last and is also the number of years that the warranty will generally last. For this project, we will estimate low.

- c. **Debt ratio** — This is the percent of the project for which you will be borrowing money. This number is typically between 50-90%, but is of course unique to each case. If your **Debt ratio** is above 0%, you will have two more boxes that will need to be filled out underneath it.
 - i. **Debt interest rate** — This rate will likely be determined by your city or whoever it is you are loaning from. For this, experiment with different percentages to get a price that is affordable.
 - ii. **Debt term** — This amount of time will likely be determined by your city or whoever it is you are loaning from. For this, experiment with different numbers of years to get a price that is affordable. This figure will normally fall between 1 and 25 years.
2. The **Initial costs** section will review the total costs of heating system installation and other installations. It is a total of the **Incremental initial costs**, the **Solar water heater**, and the **Seasonal efficiency** sections.
 - a. **Other** — If there are additional costs that are specific to your case, you may enter them here so that they may contribute to the Total initial costs.
3. The **Incentives and grants** section is where you may enter any grants your pool or community center has received for the project. For example, if you are working with a solar company that offers a financial incentive of \$1,000, enter \$1,000 into the yellow box. If you are not receiving any incentives or grants, leave the box blank.
4. The **Annual costs and debt payments** section will review
 - a. **O&M (savings) costs** — As an estimate, you may enter 200 as the number of dollars that you will spend annually on maintenance. The number may be higher or lower than this depending on the year, but it is a good assumption.
 - b. **Other** — If there are additional costs that are specific to your case, you may enter them here so that they may contribute to the Total annual costs.
5. **Annual savings and income**
 - a. **Other** — If there are additional savings that are specific to your case, you may enter them here so that they may contribute to the Total annual savings and income.

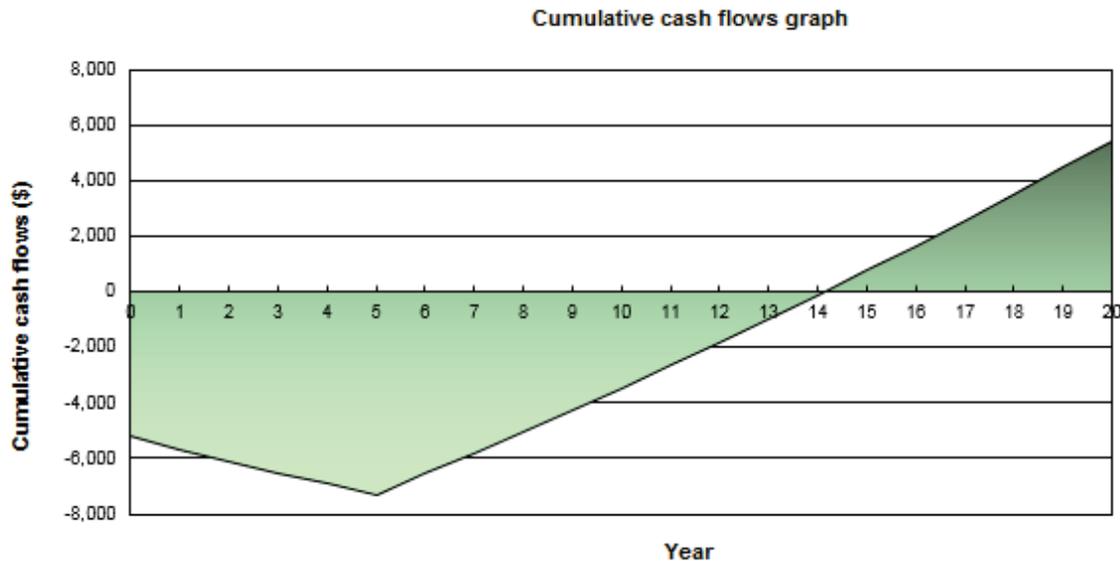
G. Conclusion

You have now completed the assessment. If you look below the **Annual savings and income** section, you will see the **Financial viability** section. This will tell you a couple of things.

The percentage listed under **Pre-tax IRR - equity** (Internal Rate of Return) is a representation of the interest yield from the project over the course of its life. If the IRR is greater than the required rate of your organization, this may be a worthwhile investment for your facility. The **Pre-tax IRR - assets** is a similar concept but instead measures the IRR on assets, meaning maintenance, repairs, check-ups, etc.

Just below the IRR figures, there is the **Simple payback** and the **Equity payback**. The **Simple payback** is how many years it will take for the project to pay itself off, while the **Equity payback** is how many years it will take for the organization to pay off the entire project. The **Equity payback** will be the more useful number for you in this situation and should be the number of years that you should expect to be paying off the project.

To the right of the **Financial Analysis**, there will be a graph that will look something like this. Your graph may look drastically different than this one, but it will be used as an example:



The point at which the line intersects with the x-axis is the year at which the project will be paid off. The graph is a visual representation of the **Equity payback** and shows what the timeline of the project will most likely look like. In this case, the project will be paid off after 14.1 years.

If the numbers in your **Financial Analysis** seem very skewed or are higher than you would like, try going back to the **Heating project** section and slightly changing the values that make the largest price difference: **Cover use, Temperature, Makeup water, Percent of**

month used, Number of collectors, and Seasonal efficiency. By toying with these numbers or making small changes in the way that you run your pool, you could save hundreds or even thousands of dollars.