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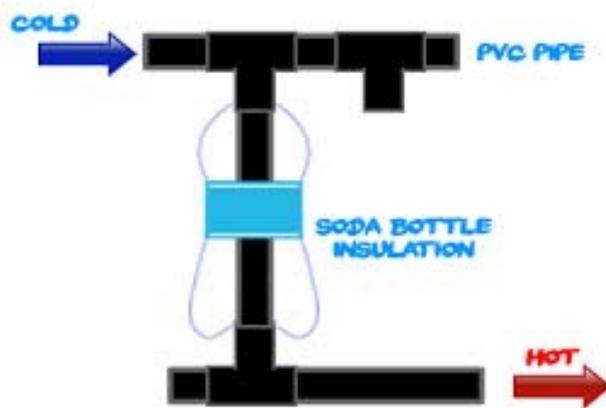
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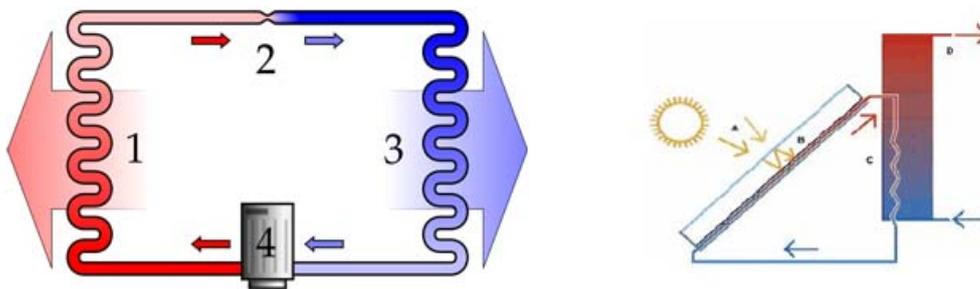


over 100,000 solar thermal systems already. There is no question that “going solar” is good for the planet’s environment, but it has a range of other benefits that make it very attractive beyond its “green – ness “. In fact, the idea that you can help move the world toward a less oil-dependent future, and save money at the same time, should be a great argument for trying to build yourself.

Our project the solar water heater, its a combination of recycled plastic bottles and used the suns radiation for heating the water passing through it, it raises the temperature of water when passed through it. We tested it and passed water which temperature from 20 degrees Celsius was increased to 60 degrees Celsius when 10 liters of water were passed through it in 30 minutes, its daily average is of heating 160 liters. This product can be made and used commercially as well . The basic purpose of this project is to use recycling to make more use of it and this also cuts pollution giving us a clean way to do things and to take a step towards a safer planet.

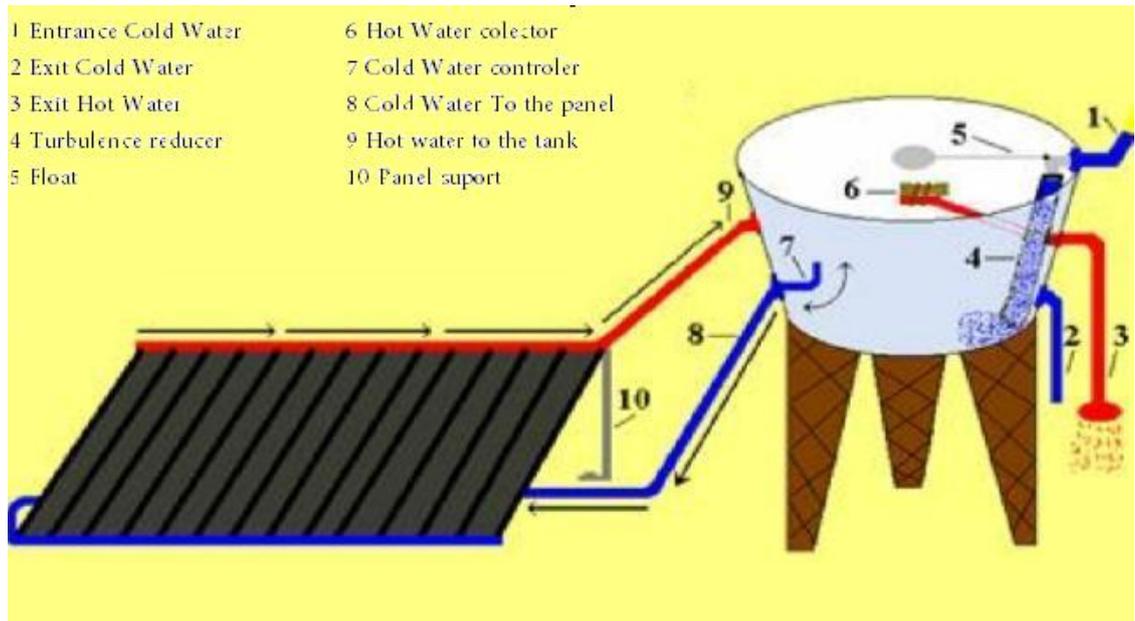


The standard solar water heaters cost a couple of 1000\$ and have copper as a main element. The Plastic Bottle solar water heater cost almost 50 \$ and is based on the thermosyphon technology which is used in many solar water heaters. It makes use of the circulation of water based on density; hot water which is less dense moves upwards while the cold water which is denser moves down. As long as the possibility of installation of the collector

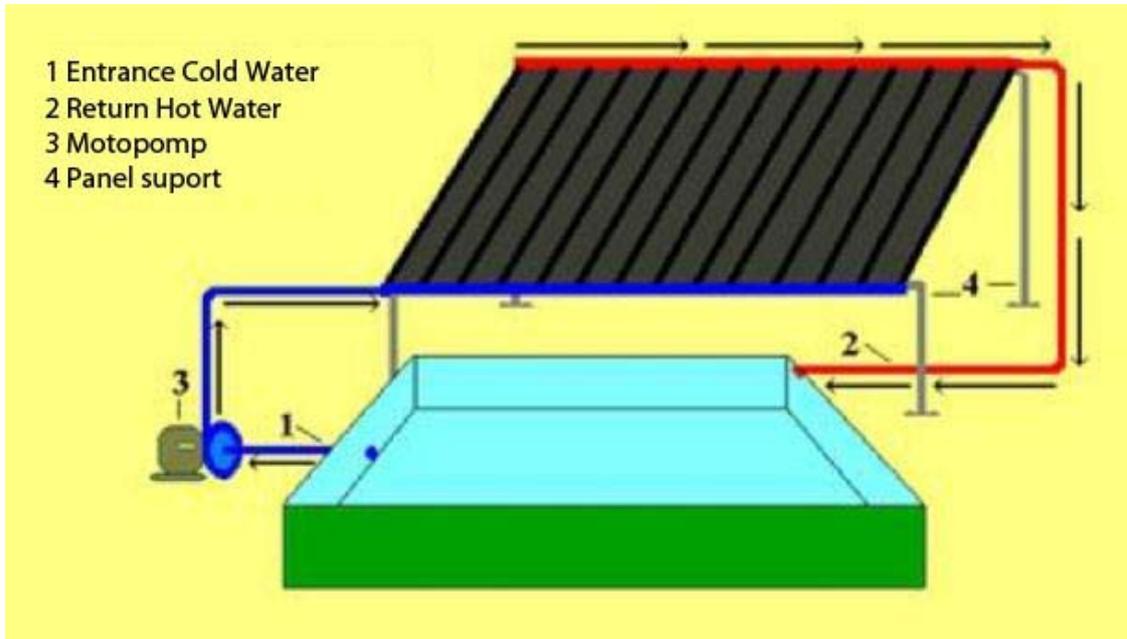


with the top of the same, ie the top bar the return of hot water, be between 10cm. and up to 3 meters below the lower (bottom) of the housing or shell, as the diagram below.

This gap is necessary to ensure the movement of water in the collector with a difference in density between hot and cold water, and that as the water heats up in columns of the collector, it rises to the top of the box or tank, while where the cold water being heavier is aimed at the bottom of the collector, pushing the hot water tank or the box, keeping the movement as long as solar irradiation.



System where the collector is higher than the box or container, an example is the heating of swimming pools. The system is equipped with a thermosensor, and the same for driving a motor, so the solar collector is producing hot water, because without it, there would be an exchange of hot water in the cold collector. It is necessary to install a check valve so that in times when the solar collector is not warming up, avoid the reverse cycle, since water from the collector is cold and heavier than the water of the box or container, and collector will function as a sink of heat, all cold and hot water stored or heated, when available in the system of supplementary electric heating.



We estimates that to heat water for a shower of one person, a 1m<sup>2</sup> panel would be enough. Materials needed for construction:

The only material required to build a recycled water heater are:

- 2L plastic bottles (60),
- Cartons (50)
- 100mm PVC pipe (70 cm)
- 20mm PVC pipe (11.7m)
- 90-degree 20 mm PVC elbows (4)
- 20mm PVC T-connectors (20)
- 20 mm PVC end caps (2)
- PVC glue
- Black matt paint
- Paint Roller
- Sand paper
- Self-amalgamating tape
- Tools – Rubber hammer, saw, wood or other material for the support.

## **The Solar Collector**

The solar collector is the component that deserves special attention, being the same, is directly responsible for performance of a solar heating system. Our solar collector differs from the conventional, in terms of materials used in its construction and thermal efficiency, because as a matter of lowering costs, we use the columns to absorb heat, PVC pipe less efficient than the copper tubes used in collectors conventional market, while limiting the temperature to levels that maintain the rigidity of PVC, without causing the softening of these, and consequently, undermine the structure of the solar heater on the upper part, causing leaks. Without forgetting the box or container, if they are of materials with the temperature limits for accumulation. PET bottles and tetra pak cartons fit properly, are the role of the box, the absorption of solar panel and glass in conventional collectors, which is designed to both protect the inside of the collector of external interference, especially the winds and variations of temperature, creating the greenhouse effect. Although simple, it contains details required in the process.

### Pet bottles:

Three are the bottles we use in the construction of it, by giving preference to the transparent (glass) in the formation of columns of thermal absorption: Lisas bottles, belts and bottles of Coke and Pepsi (new model). We use the green bottle just for the cutting of strips in different moorings, described throughout the manual. To facilitate the cutting of bottles (glass), we suggest a simple template, or cut 2 pieces of PVC pipe



100 mm: 1 to 29 cm and the other with 31 cm and then make a cut lengthwise in 2 tubes, allowing the placing the bottle in it, defining the size of the cylinder to be cut. The pipe of 29 cm used for measuring the cutting of Lisas and bottles of Pepsi (new model) and the tube of 31 cm only for the cutting of bottles of Coke.

Suggestions: after consumption of soda, rinse the bottle and let drain. Bote in the refrigerator for 2 min without the lid and take it to cover the fridge quickly. As the air inside the bottle back to the room temperature increases the volume, remains the same with the original format, eliminating the risk that, when stored in cool place, self-kneading it. If you have a few bottles, and some mashed them and if you want to take advantage of them, destampe it and add 100 ml of cold water, cover it and take the micro wave for 45 seconds, remove from oven and immediately turn it in horizontal by some 10 seconds, then leave it standing and then carefully desenrosque the cap slowly to release the steam, leaving the cool bottle without the cap. But the question is: why not use hot water? Because the bottle without the pressure of steam and support, to receive the hot water is all deformed.

Note: this operation seeks to protect itself goggle, gloves, coat, and place far enough from other people, especially children.

Tetra pak boxes of 1 liter (milk, juices, etc):

Tetra pak boxes have in their composition, 5% aluminum, 20% polyethylene and 75% of cellulose, which makes their collection and only role, thus requiring special equipment for separation of such materials .There are few companies specialized in this process, which discourages the collectors, although the campaigns leading manufacturer (July/2004 Superinteressante Magazine. The application of them in our project offers excellent results, since the combination of such materials, avoids the bend in the temperature



that will be submitted to the contrary is to use paper. For a perfect fit inside the bottles of Coke or the Lisas, cut the box with 23 cm, and the bottles of Pepsi (new model) with 20 cm in length , with 1 cut-over 7 cm at the bottom

of the box in both sizes , will fit the neck of the next bottle. There just fold it in a simple way, using the lateral bending of the same , and two diagonal folds in on top , which will follow the curvature of the bottle top, act as support to sustain the housing. We paint it with matte black synthetic enamel paint drying quickly to external and internal, used to iron, wood, etc., But avoid buying into spray, it is very expensive to paint rather than cans of 1kg.

Note: Do not use ink to glow, as will the performance of the collector, since the sun will be partly

### **Preparing the pipes:**

The reason we use a maximum of 5 bottles per column, is not to hinder the installation of the collector in relation to the height of the water box or reservoir, as discussed in Section 2.1 by end-Movement siphon, because here in the south of the country requires that is greater inclination on the grounds of local latitude. Mentioned as an example Tubarão-SC., Where I live, the latitude is 28.3 ° S, while in Brasilia, the latitude is 15.5 ° S. Back into the 4-item topics relating to the installation of the assembly. In our project we use the collector tubes and connections of the type I 20 mm weldable quality of good quality, with the size of the tubes of the columns depending on the type and number of cylinders. Remember that before cutting the tubes of the columns, check the types of bottles available, because the ideal is to choose, choose one type for each collector, here is the measure that best fits: 92 cm for columns with 4-cylinder straight To 101-cm

columns with 5 bottles of Pepsi waist (mod. new) 108 cm-to columns with 5 bottles of Coca

Note: The design of the bottle of Coca new (yellow cover) has changed, so to maintain the size of the column, merge with Pepsi (mod.novo)

Before painting the tubes of the columns with the same ink used in the boxes, we must isolate with duct tape the 2 ends approximately 2 cm, after which it is painted cut the ribbon due to the type you plug in the connections. The tubes of distance between columns should be 8.5 cm and without paint, standard measurement for all collectors, no matter the types of bottles. The assembly becomes simple to follow an order to put the components, taking care to use the adhesive only in the tubes and connections, the top of the collector where the hot water circulates. At the bottom should just fit them with the help of a rubber hammer, making the maintenance, if necessary, just undocked the bar lower, without compromising the size of the columns, as if cut would be cut, and the loss of all connections and hoses away. Recalling : to avoid leaks, the quality of the pipes and connections is essential. Watch out, the cheap comes out expensive.

To simplify the assembly of solar collector, we need to glue the three pieces of Fig.1, repeating the operation in the number of columns of solar collector. Conjuninho Cole one another to form the **5** columns. Then insert the bottles and tetra pak cartons (**fig.2**) in 5 columns, not forgetting to close the last bottle of each column, cutting off another bottle, but on top of the side cover. In conclusion , the fit of the bus below (Fig.4), closing this module. We recommend for cold regions, is shown to fill the bottom,

between the bottle and box tetra pak (Fig.3), with some isothermal not absorb moisture (eg plastic labels, plastic bags).The reason to opt for modules of 5 columns, it is about management, because it is extremely easy to upload it to the location of installation. Amend a module to another, until five at most, to avoid tension on buses.

According to **Fig.5**, we should seal the 1st bottle of each column, with strips of rubber (eg inner tubes) or tape auto merger. This prevents the escape of heat from inside the column, and prevent the wind turn the cylinders, taking the position of Tetra Pak cartons, which is upwards, avoiding loss in income.

In **Fig.6**, only two speakers, 4 cylinder straight up.For better viewing, set up to follow, step by step with pictures, part of 2 columns of solar





## **Water reservoir:**

Even the water box on the site may be used in the supply of hot and cold water, since it has a minimum capacity of 500 liters, to make available more or less than 250 liters of hot water, since we use as reservoir the upper half of the box for the solar heating system. The ideal and recommended, it would be a reservoir for hot water only, with the size corresponding to the daily number of people, and near points of consumption to avoid waste, until it reaches the hot water tank. Since the shell is responsible to collect the hot water, it is necessary a good thermal insulation, which is found in conventional batteries market, where use is high-efficiency vacuum.

These batteries have the majority of heating aid for rainy days or covert, with electricity or gas, controlled by thermostats that trigger the feature where the water temperature is below the pre-set by the user.

Our design for the character to make it economically viable for all, has no such recourse, and the shower has been replaced by common, but with the use of an electronic controller for adjusting the temperature, connected in series with the input electric energy of the shower. Common market, it facilitates the adjustment of the ideal temperature for bathing, without **the** need to vary **the flow of** water in the registry .The use of basic materials available in all regions, is of extreme importance. Applied in the project a plastic box as a reservoir of 250 liters, but that does not indicate that boxes of other materials are released, but be very careful and not use containers that contain chemicals, pesticides, insecticides, etc. because even well-washed contaminated and continue offering the potential risks to health. So to avoid inconvenience , being sure of the origin of them.

### Thermal insulation of the box or container:

As the thermal insulation has many options: from the Styrofoam as we found in several packages of supermarkets, such that comes with cold (ex.com cheese, ham, etc.). And in appliances and electronics, also plastic bags, papers, as an alternative for those who live in urban areas. In other regions we have great vacuum, such as: sawdust, wheat hulls, rice husks, dry grass, etc., But no humidity.

It is extremely easy the use of such insulation, filling boxes of 1 liter tetra pak (without leaving empty spaces), closing them again, resulting in each box isothermal block. You set these blocks in the box reservoir or use glue or tape, and finally the way you feel better, taking care to fill the spaces between the boxes, when set in round containers or rounded corners, with plastic bags, papers, etc. ..

Vale warn that if the box or container is outdoors, you should have protection against the weather, or otherwise the insulation will be damaged. As the replacement of cold water is at the bottom of the box or shell, no insulation is required at that location. Another type of insulation simple and effective but more expensive, is to put a box of water within a compartment made of wood, bricks, or even inside another larger box, enough to take a break on the side of at least 6 cm, due to filling with any of the insulation above, not forgetting that it is mandatory to isolate the cover of the box. Apply the thermal insulation, only after all the holes and connections necessary for the installation of assembly.

## **Topics relating to the installation of all**

### Dimensional system as the consumption of the country and region:

When put into practice the project in October 2002, built a solar collector with 100 pet bottles, 100 boxes of 1 liter tetra pak, arranged in 25 columns with 4 bottles each, totaling a floor area of absorption of 1.80 m<sup>2</sup>, and a plastic box of 250 liters in the role of shell, coated with polystyrene of 20 mm. It is noteworthy that the thickness of insulation is not sufficient to maintain or store the hot water until late at night.

As installed almost summer, and that with the sun around 6 hours, heats the water to 52 ° C, being necessary to mix with cold water.

But to reach the winter, the temperature of cold water in the box Shark, is around 13 to 16 ° C, against 22 to 25 ° C in summer, and that due to the difference between the seasons, in addition to the reduction of solar radiation in winter, the thermal efficiency drops from 52 ° C in summer to a maximum of 38 ° C in winter. To correct the problem, we built another collector with the same dimensions of the former, on sunny days to meet the normal consumption of 4 people. But for the summer we will increase the reservoir to 500 liters, or disable part of the collectors to prevent overheating. Important: install the collectors independent of each other, to facilitate a possible maintenance.

For those who have, or may install a box or container with a volume equal to or higher than required, a very interesting and simple solution to find the temperature and volume of hot water, s that meets their needs for consumption, is to installing the outlet of cold water to the solar collector as

low as possible. Attach the flange to the inside of the box or container, 1 adapter as internal flange, and 1 curve of 90 ° with 2 pieces of pipe at its ends, setting 1 of the adapter tubes without adhesive, and the other serves to increase the options for regulation (Pág.5, **diagram 1, item 7 - Fisherman rotating**), as by rotating the set, you varies and determines the amount and temperature of water to be heated according to season. Note: Option great a prototype in a laboratory school experiences.

Considering the above, we suggest that each is the size next to the needs of consumption of each home, each project requires the observation of various factors, and among them:

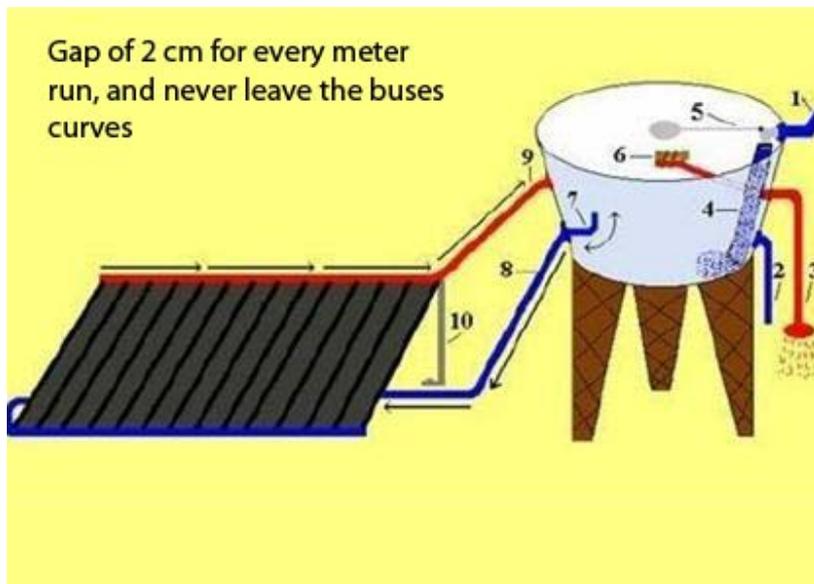
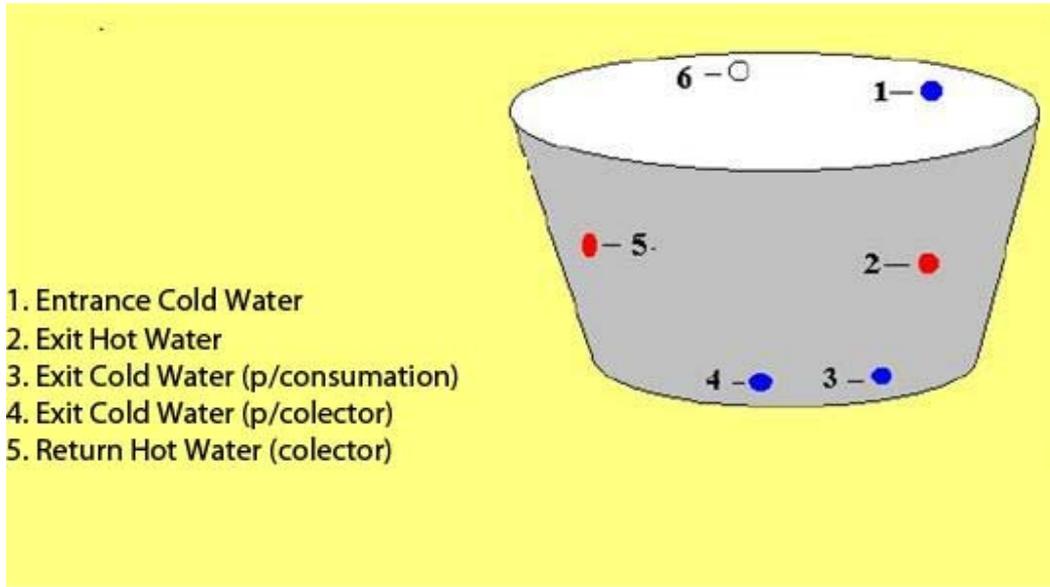
Examples: 1) position of the solar collector in relation to geographic north

2) inclination of the solar collector on the latitude

3) Region and place to be installed

On the holes to be made in cash or reservoir, we suggest

simply as references in percentage of the height of the box:



## Support for fixing the solar collector

It is at the discretion of each of the material to be used as support for fixing the solar collector, but indicated that at least the two buses are tied to bars of  $\frac{3}{4}$  galvanized pipe, or something to ensure the alignment of the collector

Important: to avoid air bubbles hinder the movement of water in the collector, you need a gap of 2 cm for every meter run, and never leave the buses curves.

Important note: never leave water in the collector fails, at risk of overheating and destruction of it.

If you want to set straight on the roof without taking into account the local latitude, should install the solar collector with at least 10 and inclination toward the geographic north as close as possible, and that will increase the absorption area of solar panels, increasing the collector to compensate for the loss of placements. It is appropriate to emphasize that almost all the problems of thermal efficiency of a solar heater, cease to exist as we approach the north and northeast.

To give a preference by the end of movement by crane, it is mandatory that the bottom of the box or heat reservoir, is always up on the top of the solar collector (as per item 2.1 Movement-term siphon), which lies to each choose the best alternative for the site, without forgetting that the talk about housing or shell, we are talking about weight, so again, do not improvise in questionable places that may collapse and cause serious problems.  
(Remember that each liter of water weighs 1 kilo)

Thermal insulation of the ducts above the collector, by the box or container

Engage the bus's top collector and hot water pipe leading to the box with Styrofoam , tying it to the tubes with strips cut from pet bottle green. Note: The polystyrene does not stand for a long time exposed to the sun.

Distance between the collector and the box or container:

The closest possible in order to minimize thermal losses while taking into account also the distances of the points of consumption, thus avoiding the waste until the water hot.

Blender with hot water / cold, simple, but practical

The site to be deployed the solar heating system, have facilities for hot and cold water, only requires connection to carry the box or tank, the installation of hot water. Where the water supply of the property is only with cold water, we suggest a mixer simple and efficient, built with PVC pipes and connections, indicated for the shower, but with some modifications, can integrate the other points of consumption in the home, such as kitchen, tank, toilet.

### Installation of electronic control of temperature to electric shower

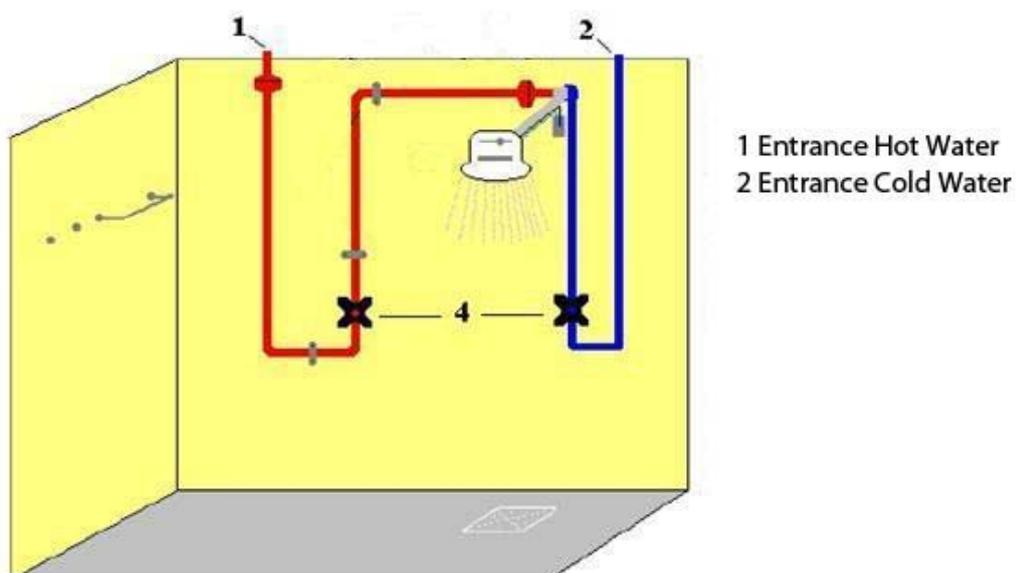
The reasons for the installation of electronic control to the electric shower , were described in item (3.2-Box or water tank).

As for the layout of links to electronic control, there are different market models and brands, containing all the installation instructions.

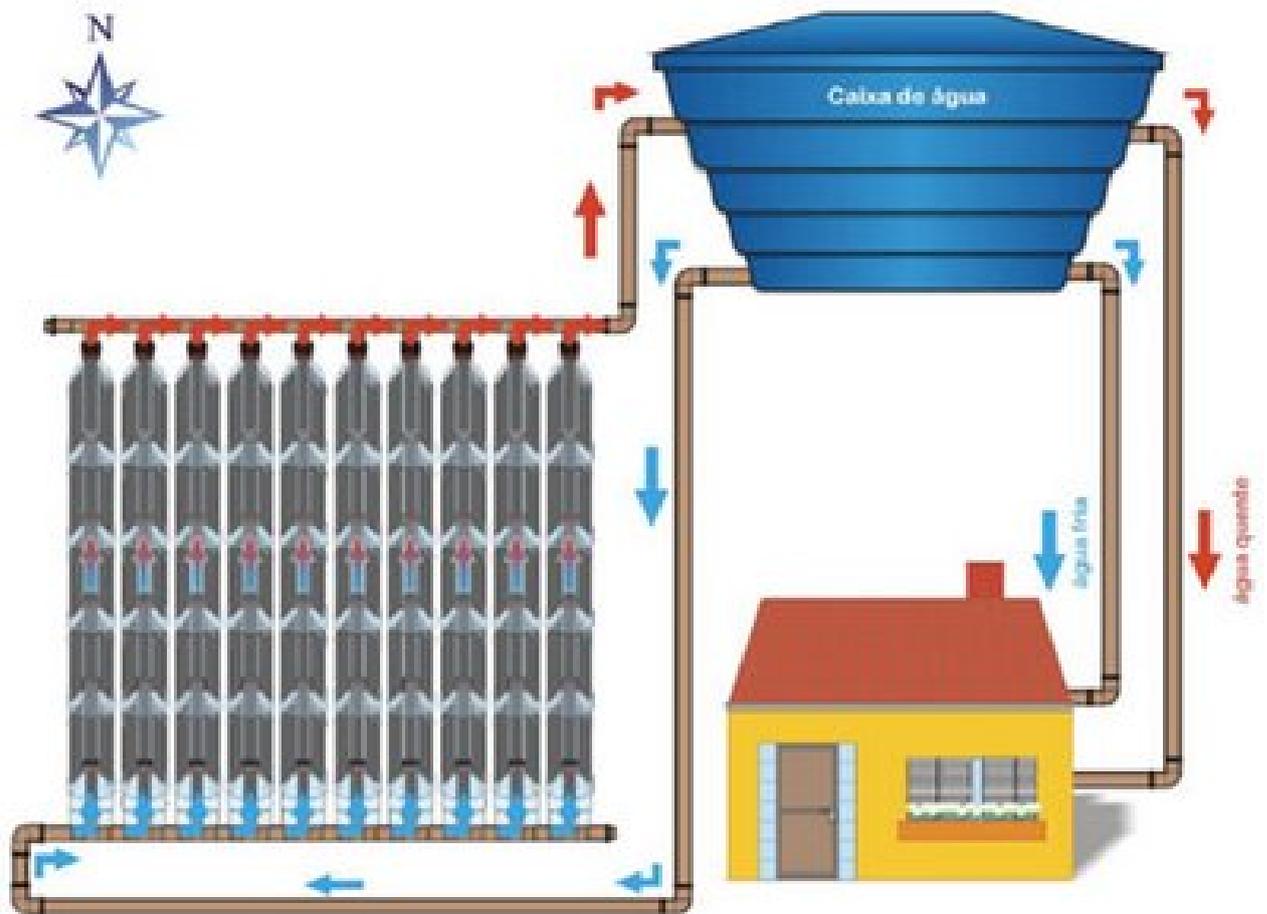
### Time of exposure to solar with thermal efficiency

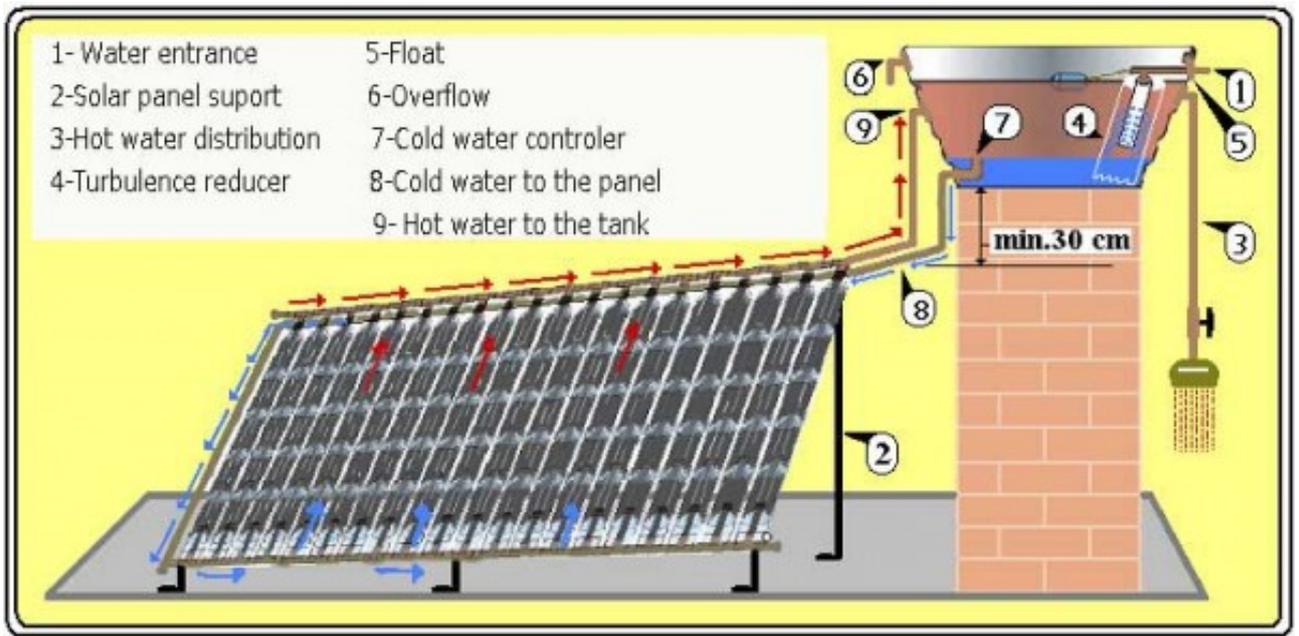
The solar heater on sunny days, the maximum temperature reached after 6 hours, but from 10 hours of the morning, we started to notice the increase in water temperature of the housing or shell.

Even in days covert , but not rainy and depending on the region, can provide satisfactory performance and economy of partial power.

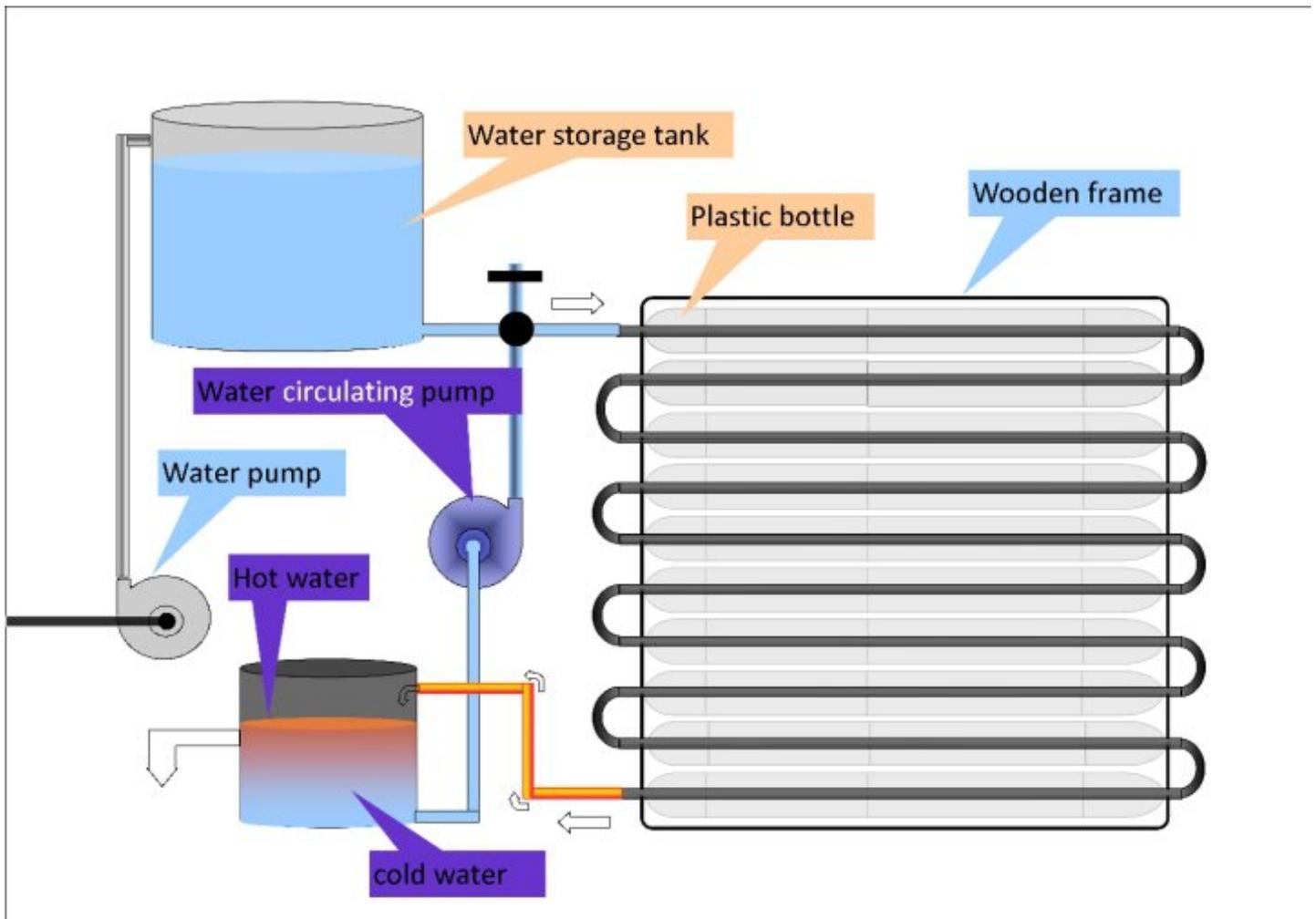


## Normal plastic bottles sistem





## Plastic bottles sistem with motopump



## The temperature difference between plastic bottle and glass



## Solar Colector





## Hot Water Plastic Bottles Colector

