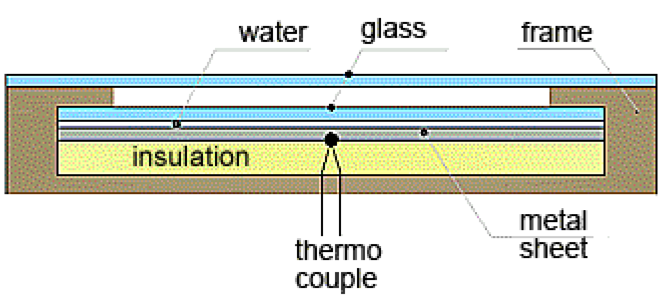
HOW TO BUILD SIMPLE ALL-SEASON SOLAR PANELS ON THE ROOF, WALLS AND WINDOWS OF YOUR HOME!

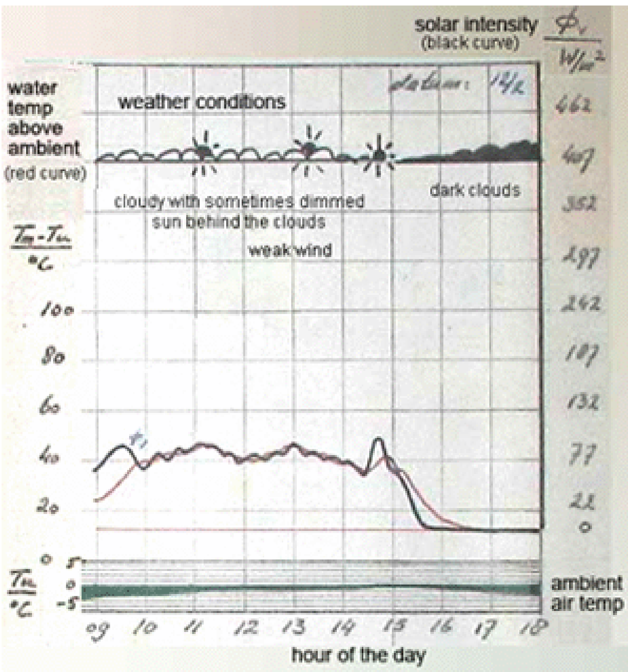
Can you imagine, solar heated 80°C (175°F) water temperature on a freezing, but sunny winter day in Sweden? This I achieved with a simple experimental device, that I built at the time for my engineer's graduation-exam around 30 years ago! Indeed a simple device, as shown here below.

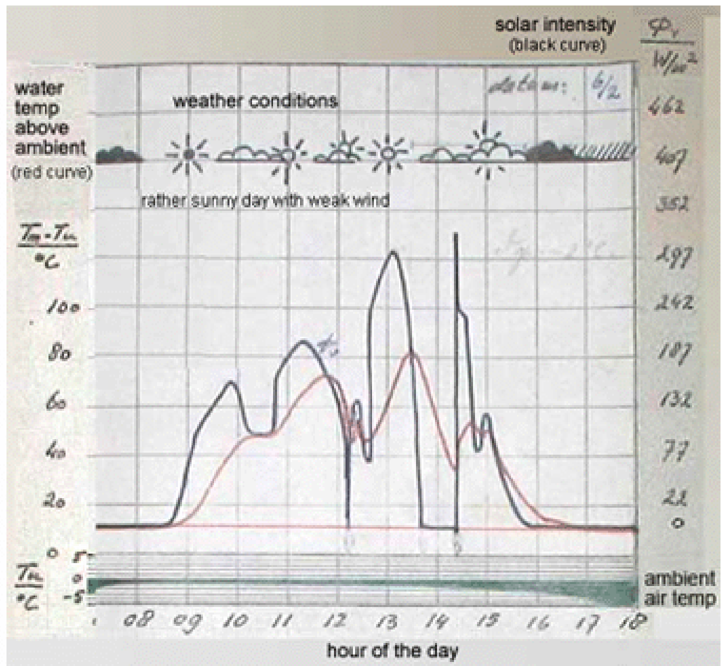


Just an insulating sheet of polystyrene, a metal and a glass sheet on top, with around 0.5 mm of water in between, a thermo couple soldered on the metal sheet to measure the temperature, a sealing frame around with a second glass sheet and that was it.

Even on cloudy winter days, still at and around freezing temperatures, I measured up to 40 °C (104 °F) temperature!

See below the two graphs below , that I measured up (among many) with this device at the time:





The "secret" simply is to know that plain water is a black-body absorber for infra-red (heat) radiation, fortunately having its peak sensitivity on the same wave lengths (1.95, 3 and 6 µm) that the atmosphere allows radiation from the sun to reach Earth's surface. Just as fortunately, common window glass is fully transparent for those wave lengths.

A water layer with a thickness of just 0.1 mm is totally impenetrable for solar (infra-red) radiation - if fully absorbs all the heat energy of it. Surely I tried to commercialize my invention during later years, but you just try to tell people that you don't need a black surface to heat water in a solar panel and they don't listen any more.

Internet did not exist at the time and not being able to reach out with common publishing methods, nor having the means to start something up myself, I gave up and more or less forgot about it. Now with the opportunity of this contest at Ecomagination, the a.m. water experiment came to my mind again. As a result I'm writing this paper now and hope others can do their advantage with it.

HOW IT WORKS

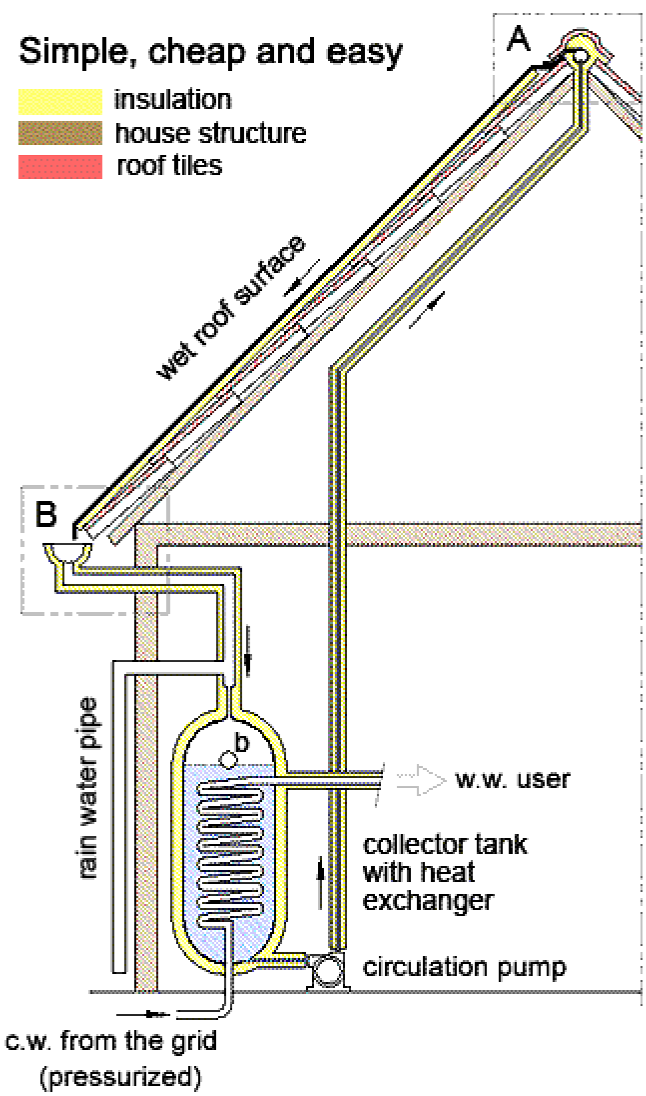
This may be the opportunity for many to build a simple and cheap solar energy system for their home themselves. It doesn't really matter in what climate zone one lives, because this method is largely INDEPENDENT from ambient temperatures.

If you use a black surface (steel sheets and tubes), these must become hot first, in order to heat the water flowing behind/through it. Naturally, if it is cold outside, it will be very difficult to generate any higher temperatures. Most of the solar heat absorbed by the black surface is lost again to the ambient air, keeping its temperature down. Most importantly, the black heat absorbing surfaces must be considerably warmer than the water in contact with them, in order to create large enough driving temperature differences. Moreover, that water cools down the black surface to its own temperature and so the remaining temperature difference is always very little. This causes that a plate panel with black surface cannot work below a certain minimum intensity of solar radiation and at too cold weather.

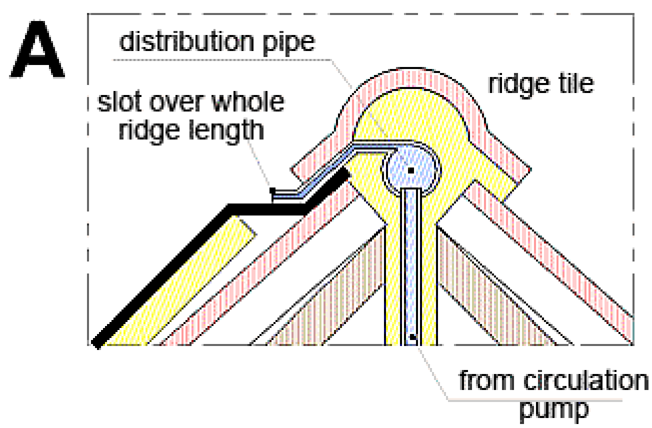
When water is directly exposed to solar radiation, such temperature differences do not apply - they are non-existent! The water is heated by instant absorption of radiation, not by any temperature difference with a black surface and so even the lowest solar intensity is absorbed instantly. Hence, the amount of absorbed heat is TOTALLY INDEPENDENT from outside (ambient) temperatures.

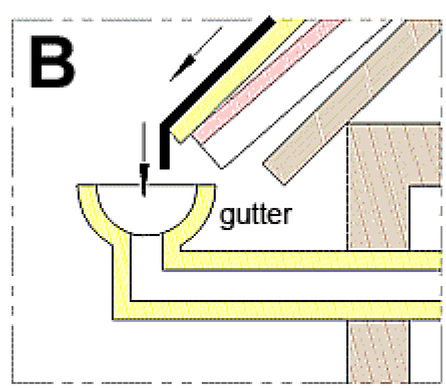
Of course, once the heat is collected and the thus heated water remains a longer time in the panel, it can loose some of that heat to the surrounding air again, thus it should flow to prevent this. In fact, the colder outside, the dryer the air is, the more solar heat it lets through (humid air absorbs a lot of solar radiation) and so the collection of solar heat by exposing water directly to the solar radiation is more effective in the dry arctics, than it would be in the humid tropical regions (where the rain forests are), but quite equal to hot deserts having dry air also. This explains why I measured these high temperatures on freezing days - the outside air was dry then! Naturally, also my little device was cooled heavily by the cold outside air, otherwise the water inside would quickly have come to boiling, because that water was trapped, not flowing through with cooler fresh water.

In a practical design, where water would be flowing behind a glass sheet, the temperature of it can be controlled by the time rate of flow of the water, but the amount of energy absorbed by it would be fully independent of that temperature. This is the great difference with a black plate/tube design.



Hence, all you have to do is to provide a flat and underneath insulated surface on the roof of the house and spray water over it, not more than to keep its surface wet all over. For this you would need a specially prepared feed water distribution pipe (view A), lying along on top of the roof - any mechanical workshop can make that on order.





The sketch shows commonly used roof tiles. If you would be building a new house, you will of course not have roof tiles there, but a flat surface of what ever material and preferably insulated beneath it to whatever extend, depending on the climate zone the house is in. You also don't need to use the whole roof necessarily. You can start with putting up a smaller section on your existing roof, to test things out, not in the least to learn about the properties of your environment and what variations in design work best for you.

Actually, the system presented here is rather overworked (view A). You may do like the poor guys in tropical Asia, who simply place some water sprinklers on the existing roof as it is. They don't want to collect warm water anyway and so it works fine for them. If you live in a tropical region yourself, even without wanting to collect warm water this way, you could do the same, just to keep your need of air conditioners down - cheap and easy!

The water flowing down the roof is collected in a gutter (view B) and piped to a well insulated collector tank, from where it is recirculated to the feed pipe on top of the roof by a water pump. Next thing you need are two temperature sensors, one measuring the temperature of the water leaving the collector tank and one that measures the temperature of the water entering it. If the difference in temperatures becomes around zero, or even negative, the circulation pump is switched off by an electrical control circuit.

Furthermore an sunshine-indicator is needed. Can be an solar-voltaic cell, or make cheap yourself with a similar device as I did my experiments with. When there is no solar radiation, the indicating device will have no output and then the circulation pump is switched off as well. Thus the circulation pump will only run, if the sun is shining AND there is a temperature rise in the recirculated water. Any electronics workshop around can make a control unit on order.

Last but not least, some water will evaporate while flowing over the wet surface, so the collector tank needs a regular refill from the main water supply. This is done by means of the same type of level switch that is applied in common water closets (floating bulb). No other controls are needed. During rain fall the collector tank may become filled to the top, where a floating ball-valve (b) stops the inflow of rain water, that then flows away through a drain pipe, as shown. This inflow has no significance, even though the temperature in the tank would go down, as you don't loose any energy with it. A good example to see the difference between temperature and energy, the latter being what you pay for!

Indeed, the wind blowing over the roof and the ambient air at all, will cool off the heated water to whatever extend, which is a loss. Mind that the water "sucks" in the solar heat radiation instantly - there is no thermic resistance, no time delay. To cool off that heat again, water has plenty of thermic resistance - it takes time to cool down. Therefore, if the water flows fast enough over the roof, it will not get the time to be cooled off very much. Nonetheless, the more water flows over the roof per unit of time, collecting a given amount solar energy during that time, the lower its temperature gets, BUT the collected energy is the same regardless and it is energy you pay for on your electricity bill, not the temperature of your flat iron for example.

Therefore the temperature in the collecting tank is of far less importance than its volume. If you need higher temperatures, you can use an electrical heater at the usage spot, as usual, just that it takes less electricity than using cooler water directly from the grid. Any degree the collector tank is warmer than that, reduces the energy need of your electrical appliance.

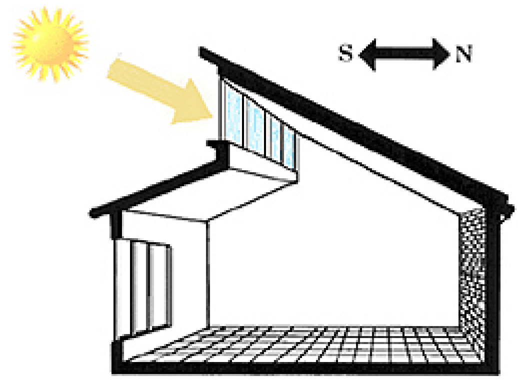
Therefore, in order to keep the volume of the collector tank down, you would yet want its temperature to be rather high, but this will be at the cost of an efficiency loss, because warmer water cools more on the roof. So you would yet want to place a glass sheet over it, preventing air to flow over the wet surface. Just that this glass sheet should not be in contact with the water, just creating a narrow gap with still-standing air only. Considering glass is a brittle material, it would be complicated to do on a sloping, or horizontal roof and require a rigid design and secure mounting (storm-proof as well). Easier to let it yet rest on the water, creating a flow-through water layer, by which it is equally supported all over, but again at some efficiency loss, yet far less than without. It all depends on in what climate zone it is. Of course you would need a smooth roof surface for that, not regular profiled tiles.

On a vertical wall, facing the sun side, it would be rather easy. Spray the wall with water and have it shielded with glass sheet hanging down, and that is kept dry - only the (insulated) wall-surface should be kept wet. In fact, in cold climate zones, where the position of the sun over the horizon is rather low, vertical walls are often a better place for a solar panel than a sloping roof, that also is far more exposed to the wind. If north-west winds dominate, the southern wall is much more shielded off, whereas the roof is not at all.

Instead of a vertical wall, a very nice effect could be made with a vertical wet-glass window, leaving visible sunlight in, but absorbing the infra-red, to warm the water. In the same time, the window glass gets warm, giving perfect insulation against the cold air outside - see an illustration on the top of the next page.

So, even if you may not collect much energy in the water, you won't loose any heat inside the house through the windows – that could be the major advantage – perfectly temperature sealing windows!

The design could be very simple if the windows are not for looking through, as is on the sketch tot he right. Just place a few sprinklers to keep them wet. This sprinklers would than recirculated the same water over and over again with a circulation pump, so the water becomes warmer than the outside air.



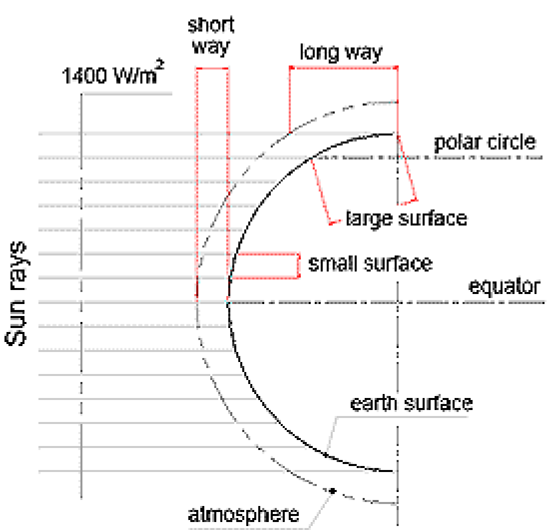
If you want to look through a window, you would instead need a water film that is trapped between two glass sheets. It keeps your home warm in winter and cool in summer - it works both ways. You should however mix some glycol or bleach in the water, or whatever chemical, to prevent micro organisms to grow and blurry the water.

WHAT IF IT IS FREEZING?

A real risk for a black surface device, that would get destroyed if the water in it would freeze to ice over night, or whenever. Either it must be drained before that, or, as usually is done, contain an anti-freeze solution, such as with glycol.

In the system proposed here, there is no such thing needed. It's an open system and when the circulation pump stops, there is no water in any cold pipes, nor on the roof. All the water is in your home, that you will keep warm anyway. If you use a radial type circulation pump, all water in the pipe to the roof (possibly going through a freezing cold attic) will flow back through it to the level in the collector tank, inside your warm home - no freezing risk whatsoever. There is also no freezing risk when warm water (from the collector tank) is pumped over the roof, because there will not be enough time for that water to freeze. Instead it would enter the collector tank colder than it came out from there and then the circulation pump is automatically stopped by the control circuit.

FREE SOLAR ENERGY, EVEN IN THE ARCTICS!



Outside the earth's atmosphere, the intensity of the solar radiation is around 1400 Watt per square meter (on a plane perpendicular to the line of sight with the sun), even in the arctic regions, anywhere outside the planet - see situation sketch left.

To get a feeling for how much it is, compare with a flat iron, or a not too big electrical cooker, that takes around 1000 Watt. Much of the solar radiation is absorbed by the atmosphere, especially when the humidity is high. On the hottest and driest places on Earth (deserts) the solar radiation on the ground can reach around 1000 Watt per square meter at peak times. In the humid tropical (rain forest) areas, it becomes hardly over 500 - 600 Watt per square meter, the rest being absorbed by the humid air.

If you live in an arctic region, where the air is cold and thus DRY, you actually can have a high solar intensity on surfaces that are placed perpendicular to the line of sight with the sun, only somewhat less than on the equator, because of the longer way the solar rays must travel through the atmosphere.

Only on the ground the intensity is low, because of the low position of the sun over the horizon. Hence, the sun side of vertical walls of houses in arctic climate zones, would be very suitable to collect solar heat - not the roofs, no way! Insulation is the problem here, but when done sufficiently, exposing water directly to the sun behind a covering and DRY glass sheet, would work perfectly well - definitely better than any black surface design could do, or at all .....

If the solar radiation for example is 200 Watt per square meter, you would thus collect 2 kW power for every ten square meters of wet surface and this is independent from the water flow rate over the wet surface. The higher the flow rate, the lower the temperature rise over the wet surface, but the energy flow into the collector tank is invariably the same 2 kW - ideally 100% efficiency.

If the collector tank has a volume of say 100 liter, getting 2 KW power, the water in it will rise 0.3 °C per minute, thus around 18 °C per hour. This is thus independent from how much water is recirculated, just the active surface is fully covered with a thin water layer. However, the higher the recirculation flow, the more drive power the circulation pump needs and that is thus the limiting factor - not pump around more than minimum needed. With losses in the practical case included, around 10 to 15°C per hour can be expected in this example (a higher solar intensity would of course give accordingly more, a larger collector tank less degrees per hour).

NOTHING MUCH CAN GO WRONG HERE. A solar panel of black-surface design is a closed circuit with pressurized water - risk for leakage is always present. Such a solar panel must be strongly built and needs extensive control equipment, which makes it more expensive. If a failure occurs, by which the forced circulation of water stops while the sun is heating on it, water inside the panel can reach boiling temperatures and cause complete destruction of the panel and resulting water damage to your house. The system proposed here is not pressurized and there is no more risk for leakage than heavy rain would give. The only thing that can go wrong here is failure of the circulation pump and then simply nothing happens. As no pressure over atmospheric can occur either, there is also no risk for reaching boiling temperatures. This system is totally safe and hazard free!

START CALCULATING YOUR SAVINGS. Now, how much do you pay today for one kWh from the grid? Assume you have 20 square meters of wet surface and in average 5 effective hours per day at a year average solar intensity of 200 Watt per square meter and a total average efficiency of 60%, you are saving the costs of 20 x 0.2 x 5 x 0.6 = 12 kWh per day (equivalent to 12 hours of continuous cloth ironing). **This is the only important thing to consider**, not the actual temperature reached in the collector tank - you pay for kWh (or Btu), not for temperature!

If and when the temperature in the collector tank would be lower than what is needed, simply use additional heating with common appliances (at the usage location of course) and you still have saved your 12 kWh per day x 365 = 4380 kWh/year, that you otherwise would have had to pay for.

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For other required information for this submission, please see my first idea submission:

http://challenge.ecomagination.com/ct/ct_a_view_idea.bix?c=ideas&idea_id=57883CC7-6C94-4DE6-A5BA-24A876BB222F