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Heatpump and Solar system savings - by Riaan Honeyborne ITS Solar.

With the price of electricity and the awareness to sustainable living sharply increasing the popularity of renewable energy technology for heating water also sharply increased. But, as with many products on the market, one can find considerably contradicting claims with regards to the different technologies used for water heating. Many of these claims and advertisement are nothing more than marketing "scams" and have no facts behind them.

At ITS we have therefore decided to try and shed some light on specifically the saving that a homeowner will get from his solar water heater or domestic hot water heatpump.

Solar water heater savings:

Theory on saving:
When solar water heaters are tested by SABS the efficiency of the system is given as a Q factor (MJ/day) – the amount of energy it absorbed for one day of sunshine. This Q factor is however calculated with an incoming solar irradiation level of 16 MJ/m^2/day. In other words, if a solar water heater was tested by SABS and was found to have a Q factor of 20, this implies that when the total solar energy arriving on your roof is 16MJ for a specific day, then this solar water heater would have absorbed 20MJ. From this result we can of course conclude that for the system tested the solar panel aperture must be bigger than 1m^2 since a system with 100% efficiency (only exists in theory) would have absorbed 16MJ for the day.

Now SABS uses 16MJ/m^2/day just as a reference value for testing. In reality the average solar irradiation hitting the roof of your house is somewhere between 20MJ/m^2/day and 24MJ/m^2/day depending on where in South-Africa you live. This average value comes from measurements done over years and so it gives us the typical daily average. In Capetown you will for example find that the summer value can even be up to 27MJ/m^2/day while in winter it could be down at 15MJ/m^2/day but if you average these values throughout the year then you again end with an average of about 22MJ/m^2/day.

So, by knowing the Q factor of the solar water heating system, you can calculate how much a system would generate but first you have to adjust the Q factor to be based on a more realistic average daily irradiation value. Without losing too much accuracy and average irradiation value of 22MJ/m^2/day can be used for all towns in South-Africa. In other words, the Q factor measure by SABS with an irradiation of 16MJ/m^2/day must be multiplied by 1.375 to give you the Q factor of the system with an irradiation of 22MJ/ m^2/day (an average day on your roof).

Looking at some of the top performing systems with regards to the Q factor measure by SABS it can be seen that at best a top quality 1m^2 flat plate collector will give you more or less the same energy output as a evacuated tube collector with the same physical footprint (the actual aperture area of the evacuated tube collector is actually much lower but the round tubes enable passive tracking of the sun resulting in a similar output). The high ranking SABS Q values for systems like this are in the order of 7MJ/day. Converting this value now to a Q factor based on the more realistic incoming irradiation of 22MJ/ m^2/day the Q factor of this system in real life will be about 9.6MJ/day. Therefore for every square meter of solar collector you have on your roof you will, if at all, not get more than 9.6MJ/day.

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Actual saving:
So let's look at how much a solar system that got a SABS Q factor of 20 can save you. Now we know the Q factor of 20 was measured with an irradiation value of 16 and so first we must scale this to the more realistic average irradiation level of 22. Therefore the Q factor of 20 must be multiplied by 1.375 giving us a new Q factor value of 27.5MJ/day.

When you buy electricity, the units are measured in kWh. Depending on the area you live in you will currently pay about R1/kWh for residential use. To convert MJ/day to kWh you simply divide by 3.6. So, this solar system will save you 7.64kWh per day or, in Rand, more or less R7.64 per day (R233/month). If we look at the currently projected Eskom tariff increases, this will result in a 5 year saving of about R21000.

Please note that you will only save this much if you use this much water. If the solar system generates 150L of hot water per day but you only use 100L then your saving will be less since you are not using all the energy that was absorbed. Also note that if on this same system you use 300L per day you will still only save R7.64/day and the rest of the energy required to heat the "extra" 150L will need to come from the backup electrical element.

The saving calculated above also assumes that the solar collector panels are facing towards solar North with an inclination angle of Latitude + 10deg. Variances in the facing and inclination of the solar collector panels will decrease the system output.

Conclusion on solar water heating savings:
Looking at the theory and calculations above it is easy to see that no matter what solar collector technology is used (evacuated tube, U-tube, flat plate with Tinox coating etc) you can save up to about R2.60/m^2/day. So if you install a top quality 2 x 2m^2 flat plate collectors or a 24 tube evacuated tube collector (58/1800 size tubes) on your 200L geyser you can expect to save as much as R10.40/day (R317.20 per month). So next time a solar installer promise you a R600 saving per month using 2 x 2m^2 panels feel free to question his/her integrity or understanding of solar systems. Using a geyser blanket and an element timer can improve your savings a bit by reducing the standing losses but it will not amount to hundreds of Rand.

Also from the above it should be clear that investing in a solar water heating system can be a very good investment. Looking at the Q factor of a system compared to the price it is possible to find a solar water heating systems (retrofit – connecting to existing geyser) that can pay for itself in less than 2 years with the current rebates and Eskom tariffs and result in a serious saving over 5 years.

Heatpump water heater savings:

Theory on saving:
With domestic hot water heating things work a bit different. A heatpump is basically just a very efficient electrical water heater. It uses a bit of electricity to drive a fan and compressor while the thermal energy is extracted from the surrounding air. The efficiency of a heatpump is normally given as a factor called COP. If a heatpump is stated to have a COP of 4 and it is also stated that the heatpump has a output capacity of 4kW it means that the unit will produce 4kW of thermal energy (exactly the same as the heat output of a 4kW electrical element commonly found in 200L geysers) but only uses 1kW of electrical energy. If such a heatpump would be connected to an existing 200L electrical geyser it would result in a 75% saving in electricity consumption.

The COP factor of a heatpump is however a function of the ambient air temperature and the desired hot water temperature. The colder the ambient air temperature and the warmer the desired hot water output the lower the COP. For example a COP of 2 is not uncommon for a well designed heatpump when working at 0degC ambient and generating 60degC water. For the typical domestic use and ambient temperature found in South-Africa a COP of 3.5 can be used for conservative saving calculations.

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Actual saving:

With a heatpump the actual saving is really dependant on how much water is being used. Let's assume again a house with an exiting 200L geyser. If 100L of water is used per day, then the heatpump only needs to heat 100L per day. On the other hand, if the occupants of that house use 150L in the morning, 150L in the afternoon and 150L in the evening then the heatpump would have heated 450L per day.

ITS have done some consumption logging over the last years and the measurements have shown that a family of 4 with a 200L geyser that uses water relatively conservative (only showers and also not the high flow rate type) uses about 16kWh per day for the geyser. If this same family now have a heatpump installed they will use only 16/3.5 = 4.57kWh/day. Again assuming R1/kWh they would therefore save R11.40 per day.

If we now look at another family that have a big bathtub and some nice high flow rate showerheads and we assume they are using 30kWh/day on their 200L geyser (in other words the 200L geyser is reheating more than once per day) then the same heatpump will now save them R21.50 per day.

Most manufacturers recommend that the heatpump operating time be limited to not more than 12 hours per day. So, with a 4kW heatpump you can heat up to 1000L per day.

Conclusion on heatpump water heating savings:

From the theory and calculations above it can be seen that a domestic hot water heatpump will provide a very similar saving for a family that uses hot water conservatively and have a properly sized solar system. If however the demand on the geyser goes up a little, then the heatpump will provide a better saving.

About ITS Solar:

ITS Solar is a professional manufacturer and international supplier of solar hot water systems and heat pump technologies with more than 20 years of experience in various technologies.

With our head quarters in Cape Town, South-Africa we have depot's throughout South Africa and neighbouring countries, supplying our network of dealers with our advanced water heating systems.

Supplying over 300 companies - from retailers, distributors, solar installers, plumbers and pool maintenance companies - ITS Solar pride themselves on their unrivalled knowledge and technical expertise in the water heating industry and are pioneers in this regard.
With thousands of systems currently installed throughout the country, ITS have been involved in the design and supply of a large number of projects ranging from domestic, to commercial, industrial, and agricultural applications.

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