Not understanding the law of SANS10400 XA 2 can have dire consequences for architects, quantity surveyors, builders and property developers - James Green as Chairman of the Sustainable Energy Society of Southern Africa (SESSA SWHDC) and CEO of Ubersolar points out what you need to know about solar water heating

Solar Thermal (Solar Water Heating) – How to get it right first time – SANS 10400 XA 2

South Africa's habitual practice of introducing laws, regulations, policy or appointments that are well intended, without clearly thinking through the consequences frequently leads to confusion and sometimes chaos.

SANS 10400 XA2 is a great idea (and indeed law) in trying to make new buildings more energy efficient. The prevailing problem although introduced several years ago, is that no one actually knows how to interpret it. For building professionals the solar thermal industry has done little to make it easier.

Other examples of well-intended policy included the new visa rules introduced in 2015, which were intended to stop child trafficking (a good cause) although there was no real evidence of it in South Africa. Their introduction had very detrimental consequences, causing a crash in the tourist industry and foreign investment.

More controversially the President's appointment of a new Treasury minister (unknown other than for having had his home burnt down by dissidents) for no known reason triggered financial losses of billions to the economy, and an immediate devaluation of the Rand.

Whether SANS 10400 XA 2 was consequent upon the government looking to comply with carbon reductions through reducing electricity consumption, a precondition of the World Bank financing on the 2 largest coal fired power stations in the Southern Hemisphere, (Medupi and Kusile), I don't know.

But with climate change increasingly evident, and even the worst skeptics beginning to accept that man made carbons are a major contributory factor, particularly since the 1970's, anything which helps reduce carbon emissions has to be supported.

In South Africa 15%-18% of its electricity power generation is used just heating water. In Europe and the USA gas is predominantly used which is both more efficient, cheaper and from a carbon perspective more friendly.

Ironically one other resource South Africa has in abundance, other than coal is sunshine and high solar radiation. This provides the almost perfect conditions for solar thermal heating but both homes and business have failed to embrace

the technology with less than 2% market penetration. This is less than 150,000 high pressure solar water heaters in a market of over 7m electric geysers.

Government initiatives to support energy savings have been both stop-start-stop, badly orchestrated, and ineffective. 100% funded programs into low income homes were badly managed, riddled with corruption and fraud, and an exemplary example of what a solar roll out should not have been. One only has to take the Gautrain past Alexandria to see solar systems facing all points of the compass, leaning over backwards like drunks, and leaking.

Leading by example the President's 'Nkandla' shows no signs of solar water heating or other energy efficiency. Perhaps (but probably not) the law was ignored there also because nobody really understands what needed to be done.

To be fair there is little reason why architects, quantity surveyors, let alone the public should have any understanding let alone interest in water heating or indeed replacing water heater electricity through solar. Neither are exciting subjects and the solar thermal industry has been as unsuccessful in educating and increasing awareness as they have with installation.

Add in the professionalism or rather lack of it of the solar thermal industry that sells products on 'blind faith' and every bit of information you don't need to know (similar to the back of a food packet), rather than the science and performance of the solar system, and it is no wonder that skepticism and an element of distrust exists within those industries that require years of study and qualifications.

From my personal perspective, it is beyond extraordinary that there is an industry that is oversupplied with different solar thermal products (over 200 high pressure SWH systems were tested and passed by the SABS at the end of 2012), and yet almost without exception no manufacturer or supplier tells the purchaser what the performance is.

Imagine buying a car without knowing what the fuel consumption is, or the speed and acceleration, or the type of engine, or the service requirements, or whether it actually works when the weather is hot or cold.

Indeed every other electrical appliance is sold with a rating in Watts or kWh. Whether it is an electric geyser, kettle, washing machine, hairdryer or solar electric panel, but not a solar water heater. Frankly the promises of it producing 'lots' of hot water is totally meaningless, and the reality is most won't.

SANS10400 XA 2 is here to stay and while it is law, and now starting to be policed, with the price of electricity having risen and continuing, going solar is not only about meeting environmental and energy targets, it can and should be of enormous financial benefit to the consumer.

Demystifying water heating

In reality it is not difficult to understand. The specific heat of water formula enables one to easily calculate the amount of electricity consumed heating water with an electrical resistance element.

As people wash at approx. 40 °C the amount of electricity used for every 36litres out of the showerhead or put into the bath is 1kWh.

As most showers flow at a rate of 16-18litres per minute, 1 minute in the shower is 0,5 kWh. As a typical average cost per kWh is R2,00 (some places more, others less) 1 minute in a shower costs about R1,00.

As a full bath uses about 160 litres of water it will use 4,5kWh of electricity and cost in electricity about R9.00

So to do a simple energy hot water consumption audit you can take the number of minutes that all the people in the home shower in 24 hours. Divide by 2 and you have got the kWh consumption and with the cost per kWh you have the cost of heating water by electricity.

As an example 4 people in the shower for 7 minutes each (in 24 hours) and with factors such as heat loss you will be using 15kWh.

SANS 10400 XA2 requires more than 50% of water heating by an electrical resistance element to be replaced. Using the example of 4 people this means about 7,5kWh.

That's the basics, and although it is a little more complicated in the detail the guideline above will be 95%+/- accurate across the country through all seasons.

Meeting the Law for Solar Water Heating

By law all solar water heaters that are installed in South Africa have to be compliant with SANS 151 and SANS 1307.

That means that both the tank and the solar collector need to be compliant.

You cannot just take any tank, (it must be SANS 151 passed) and any solar collector (imported from China or elsewhere), bolt them together and think that it is SANS compliant. It isn't, unless the solar system has been tested and passed under SANS 1307 at the SABS.

Unfortunately many developers and builders are installing such systems, but not only are they breaking the law, it may be a big mistake that comes back and bites them.

A solar water heating system that is used to heat high pressure water (as provided by municipalities) while being relatively low tech, does have significant safety aspects to be considered, particularly if it is in stagnation, when the solar hot water is not being used, for example when people are away on holiday.

In much the same way as the law requires a Temperature Pressure valve (TPv) to be installed, if it is not and the thermostat fails (they do), and the electrical resistance element continues heating the water, the tank will explode with such force that it will go through 3 floors of concrete.

Fitting a solar collector to a tank where the builder or developer does not know how the technology works in detail, and has not been tested for safety, is a really high risk strategy, cutting corners to save pennies, which could have really dire consequences.

Meeting the SANS 10400 XA 2 test

If you have an informed estimate of the kWh that will be used in heating water in a new or existing home, you could choose a Solar Water Heater with that "deemed" kWh output on an average day in South Africa. If you need to save 50% of the kWh (to comply with SANS 10400XA 2) again you choose a SWH that does that.

But most solar water heating manufacturers don't tell you and are reluctant to disclose this critical information. You only have to go on to almost any solar water heating Internet site and look for the performance or call a supplier and ask for the performance information.

Now it gets a little complicated here so bear with me.

Unless a SWH has been tested under SANS 6211, which provides a performance measure called a 'Q' factor, one has no idea really of what the performance is. Again rather like a lot of government rules it is both confusing and a little complicated.

The SABS used to test solar water heating performance at 16MJ m2 p/d average solar radiation at the request of Eskom.

However the average radiation in South Africa is not 16MJ m2 p/d but approximately 20,5MJ m2 p/d.

The exact reason for this instruction by Eskom remains unclear and confused and was compounded by a complex irrational and convoluted formula for calculating rebates on solar water heaters. The incentive rebates that were paid were not based on a solar water heater not so much saving energy (kWh consumption) but reducing the demand on their (Eskom's) electricity supply (MW peak) in the morning and evening peak.

You will recall that load shedding generally occurred in the evening, when factories had closed for the day, and offices had gone home. It was largely attributable to water heating with kettles being boiled for hot water washing and cooking in low-income homes, and hot water being used from electric geysers,

which then turned 'on' causing a huge spike in demand. Remember the TV advertisements 'Turn Off Your Electric Geyser".

The reality, although Eskom would firmly deny it, is that offering rebates to go solar was to benefit them, in helping balance the morning and evening peak, where they had a problem, and was not to save energy or carbon emissions. Indeed Eskom favoured inefficient solar systems, which required electrical back up to be used. They even skewed the energy rebates in this way penalizing those SWH systems with the greatest energy savings. Selling electricity is after all their raison d'être.

Now Mega Joules is really just a different measurement unit to a kWh unit. The average kWh per day from solar radiation or insolation in South Africa is about 5,5kWh, or put another way if one could capture the energy from the sun hitting every square metre of earth in South Africa the average energy would be 5,5kWh.

To turn kWh back into MJ m2 per day, multiply the kWh by 3,6. So 5,5kWh per m2 p/d is about 20MJ m2 p/d.

Taking the performance 'Q' factor of a SWH at 20MJ (as tested by SANS 6211) and dividing that figure by 3,6 gives one the "deemed" kWh output. If however only a 'Q' factor at 16MJ is provided you need to gross that up to 20MJ, (multiply the 'Q' figure by 1,185) and then divide that by 3,6.

That is the science and theory, but remember the actual performance of a solar water heater may be higher or more likely lower than a laboratory test at the SABS. Orientation, inclination, shade, and regional differences across the country may all affect the actual performance. To really prove the performance monitoring and verification equipment needs to be installed.

Now it gets simpler again.

As architects, builders, quantity surveyors, developers or homeowner need to comply with SANS 10400 XA 2, they need to know both the likely kWh consumption that would be used by an electric geyser and the performance of the SWH they are looking to purchase.

Reverting to the example of 7,5kWh X 3,6 = a 'Q' factor of 27 at 20MJ m2 p/d or a 'Q' factor of 23 at 16 MJ m2 p/d.

That is the basic science and solar thermal mathematics out of the way.

Choosing a Solar Water Heater

Frankly I don't believe it matters what or how the technology works, whether it is a genie rubbing a lamp, a piece of black pipe on the roof, a flat plate collector, an evacuated tube collector, or a multiple of variations thereof including split

systems, direct, indirect, thermo syphon, pumped, in all of the various permutations, let alone all the different makes and sizes.

The question is does it produce hot water, how many kWh does it save, is it reliable, how long will it last, and the most important, what does it cost.

But without knowing what the "deemed" kWh output is, you can't make an informed purchase decision, or as a professional (architect, QS, etc) specify with any accuracy what system you might use.

By taking the 'sticker cost' and dividing it by the kWh savings multiplied by the cost per kWh you can calculate the payback period.

By having the performance savings per day you can calculate the Return on Investment (ROI) on any projected period.

By choosing a solar water heater that meets the minimum kWh saving requirements under SANS 10400 XA 2, you can install a solar water heating system with confidence.

If you choose a solar water heating system that is modular and 'plug and play' you can not only install the lowest cost system for the required kWh saving, but also provide the homeowner with the option of expanding the system, to save 100% of the electricity used, and also to enlarge it at some time in the future.

You can also provide the consumer with probably the highest financial returns they will ever get on any investment for the money spent.

Other Technology for SANS 10400 XA 2

Depending on the project, the size, the space available for solar collectors, the required volume of hot water, the minimum temperatures that the hot water needs to be kept at and other factors, other water heating technologies such as heat pumps and gas boilers may need to be considered either in stand alone or combined solutions.

Comparing the advantages and disadvantages of different technologies is a separate chapter on its own. However, in summary I believe that solar thermal retains a major advantage on domestic installations over heat pumps, but large heat pumps for applications such as hotels can be a great solution, particularly if combined with solar thermal as pre-heating. Likewise the latest gas boilers, even when using bottled gas, are both an economic and viable solution for applications such as hospitals, again when combined with solar thermal in pre-feed or preheated water.

The Ubersolar Sales Pitch

I wouldn't claim that the Ubersolar Solar Water Heaters, there are 34 different sizes in kWh outputs, in the 100l to 400l range, are better or worse than any

other solar water manufacturer's product. Commercial applications can cater for almost any size of up to 30,000 litres or more.

I would however state categorically that they are the best value for money, providing the fastest payback on investment and the highest returns on investment.

In addition they are genuinely 'plug and play' in their approach. Both retrofits (where the existing hot water tanks are used for storage), and complete systems both solar collectors and tanks provided, provide combination solutions for any application.

For the architect or QS, builder or developer, not only is the installation exceptionally quick and easy, but meeting the SANS 10400 XA 2 requirements is achieved at the most competitive cost, and yet provides the flexibility to be added to post initial installation to achieve 100% savings on the hot water consumption.

For example on a domestic installation a 150l electric geyser can be specified and installed on a 3 person home, have an Ubersolar collector and kit installed saving 4,5kWh (being 60% of what the tank would use to heat the tank of 150l by electricity) thereby meeting SANS 10400 XA 2.

The homeowner can subsequently install an additional solar collector to increase electrical savings to 100%. Where even more hot water is required, (and frequently it will be), a further system can be installed in series and combined, increasing the water capacity to 300l or more, and again with solar energy savings of up to 100%.

With the prices of electricity at 2016, the payback periods including installation are typically 2 - 3 years on all systems irrespective of size, and should provide life expectancies of 25 years and more, with minimal maintenance requirements.

Summary

As stated earlier in this explanation I would agree that the solar water heating industry has done itself a disservice by not being transparent and not meeting the standards that both professional and homeowners should expect when investing in renewable technologies.

A lack of education and awareness is a major problem, and laws such as SANS 10400 XA 2 should always have been accompanied by clear guidelines. The explanation and the science (outlined above) hopefully provide simple clarity as to what needs to be done as the minimums.

Indeed although government has come out with good policy, bodies such as Eskom confused the issue, representing their book rather than energy efficiency and saving carbon emissions. The examples (particularly when low income homes fitted with solar water heaters are looked at) created the image of a

'cowboy' industry that did considerable harm and tarnished the solar thermal industry.

In other countries, Cyprus, Israel, Germany, Austria, the Netherlands, and others solar thermal has been embraced with huge success. South Africa has not done so, despite having the almost perfect weather conditions to do so.

It can now change with solar technology that meets the objectives of being cost efficient, energy efficient and reducing carbon emissions benefiting all.

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