At last! An Energy Saving Device that ACTUALLY DOES save energy!

by ROSS TESTER

FUTURE WAVE™ ENERGY SAVER

During the past few years, SILICON CHIP has exposed some decidedly "shonky" power-saving devices. So it gives us great pleasure in "exposing" another power-saving device . . . one that actually lives up to its claims. The FutureWave Energy Saver WILL save energy and therefore money. And we have the test figures to prove it.

We first saw this device on one of the tabloid TV shows late last year. Typical of these shows, the report was full of "gee whiz" and short on substance. We wondered if the claims being made were real . . . or was it just another in the long line of power saving devices which don't quite stand up to a technically-sound examination.

Developed by a couple of electric motor rewinders in a shed on Queensland's Sunshine Coast, the FutureWave Energy Saver was claimed to reduce electricity consumption by a rather significant amount. They claim up to 80% – a figure we can't quite replicate – but the savings we can measure are not too far away.

But we are getting a bit ahead of ourselves. Shortly after we saw it on TV, we tried to contact FutureWave via their website and emails – without a lot of luck. It turns out at the time they were simply too busy trying to keep up with demand following their TV exposure to have even more media exposure – which could further increase demand.

But we persevered, eventually tracking down a mobile phone number which was not only answered but we were promised that someone would get back to us within a week or two. It was explained to us that FutureWave had moved to new premises and significantly ramped up their production capacity, so now they were happy to talk to the technical media which would put their device under much more scrutiny than the TV programs had.

They were well aware of SILICON CHIP (in fact they subscribed) – so were also well aware of the damning reports we had published on previous "energy saving" devices. More to the point, they completely agreed with us!

But they were also very quick to point out that the FutureWave device went about its energy saving task in a completely different, scientifically proven way (more on that anon) and it was also specifically intended for certain electric motors, the main target market being swimming pool and spa pumps.

They were confident that FutureWave Energy Saver would stand up to SILICON CHIP's scrutiny and measurements.

In due course, a FutureWave Energy Saver was delivered to the SILICON CHIP office. Yours truly was given the task of reviewing the device, mainly because I happen to be the only one with a swimming pool in the back yard!

The FutureWave Energy Saver

It's housed in an ABS box measuring 390 x 300 x 150mm. The lid of the box is clear and hinged, opening to allow access to a limited range of user controls. There are two large 3-position switches, one of which selects the mode of operation – full power (used, for example, when backwashing a filter), energy saving (ie, controlled by the unit) and off. The second switch selects the amount of energy saving – high, medium or low.

There's also a small knob which appears to vary the amount of time the FutureWave remains in its various modes, along with a couple of small pushbuttons which, while labelled "run" and "start/stop", have uses which were not immediately obvious. Perhaps these are explained in the operation manual which, unfortunately, our test unit did not come with.

Above these controls is a LED display which gives a readout of the pump supply frequency, which varies according to the energy saving setting.

User controls on the FutureWave Energy Saver are minimal: two large switches controlling mode and energy saving level. Without instructions, we were unable to work out the controls at the top but the LED display reads the frequency supplied to the pump motor.

There's a 230V AC mains input cable and, on the underside, a 230V AC mains socket, into which your pool pump plugs. And that's just about it as far as the user is concerned.

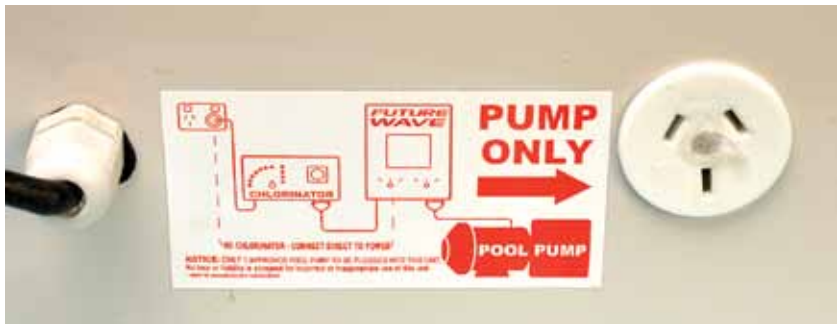
How it works

The FutureWave Energy Saver is based on the assumption that the vast majority of pool pumps are more powerful than they need be for proper filtering of the water.

There is a very good reason for this – no pool pump is used continuously (apart from wearing the bearings out, the cost of electricity would be prohibitive). But the pump almost invariably needs more "grunt" whenever it is started to overcome the initial resistance of the filter and getting the water flowing through it. The amount of power needed depends to a large degree on the type of filter.

But once operating, the pump doesn't need to keep pushing that amount of water through the filter – in fact, there is some argument to suggest filtration is better with the water flow just enough to pass through the filter medium. FutureWave themselves have published several field tests, both in large public and smaller private pools, which show no deleterious effects in pool water quality by using their device with lower flow rates.

So what we normally have is a powerful pump pushing too much water through a filter; a pump that uses a quite



The FutureWave Energy Saver is perfectly suited to do-it-yourself installation. There is no plumbing or wiring to install: all you do is unplug your pool pump from its mains socket, plug it into the FutureWave and then plug the FutureWave back into the mains socket. If (as would be the norm) your pool pump operates via a time switch, the FutureWave plugs into it. Installation complete!

significant amount of power at start-up, then continues to gobble power as it runs at too fast a speed.

How much power?

A typical pool pump for a 50-70,000 litre pool (ie, a reasonable-size backyard pool) would be rated at about 1kW (~1.3hp). If the pump is run for a typical five hours per day during the swim season (depending on location, say 7-8 months, more with heating) that could be as much as 1000 x 5 = 5kWh x 265(days) = ~1250kWh.

Add to that the pump/filter use during the off-season (most pool owners would drop it to about 1-2 hours per day) and you could add another 180kWh, or about 1430kWh for the year.

At the current (at time of writing - see www.energyaustralia.com.au/State/NSW/Residential/Products-and-services/Electricity/~/media/Files/Residential/Pricing/2010/NSW_RES_PL.ashx) electricity rate of about 28c/kwh, your pool pump alone is currently costing you about $400 per annum. (Remember the high usage of a pool pump is likely to push you into the highest "balance per quarter" rate which cuts in at 1750kWh/quarter). Even at the sub-1750kWh rate (~19c/kWh) you're still up for the best part of $300 per annum.

And that's before the looming electricity price hikes (~18%?) – and, if it ever happens, a carbon dioxide tax.

Wouldn't it be nice to cut that down by half, or even three quarters? And at the same time, save in pump wear and tear, noise and (if it is important to you), your carbon footprint. That's what the FutureWave Energy Saver promises.

But does it deliver – and if so, how?

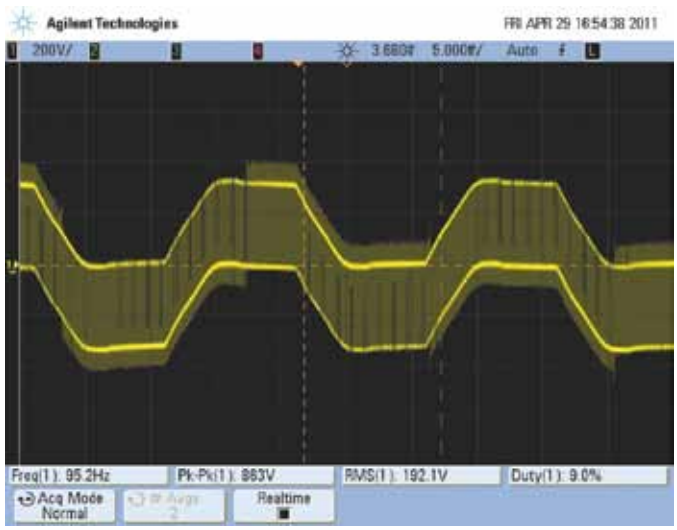
According to FutureWave Energy Solutions, the Australian developers of the FutureWave Energy Saver (they're based on the Sunshine Coast of Qld), this is how:

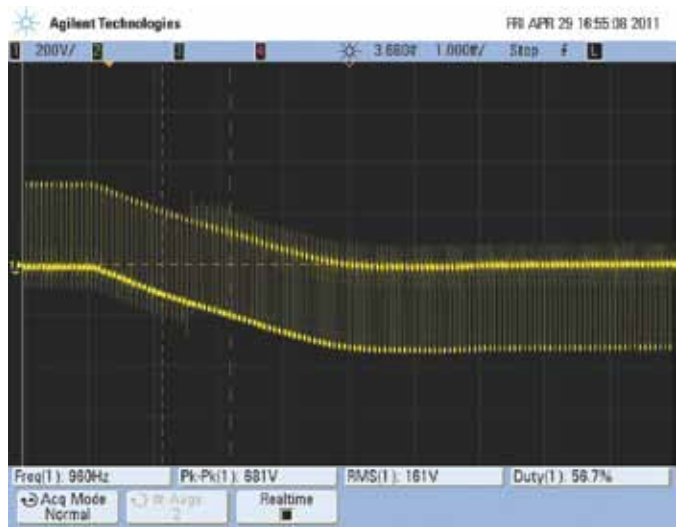
"The Future Wave Energy Saver will soft start the pump motor, removing the huge initial start up demand of electricity. This start up process will take about 20 seconds to initiate. The pump will then operate at close to its normal rate for another 20 seconds while it primes the pump. When the pump is fully primed there is no need for it to draw so much energy to work effectively so the Future Wave Energy Saver will then wind the motor down to the energy saving level selected, saving significant amounts of electricity."

That's an interesting comment: "wind the motor down". The way it does this is the basis of the system.

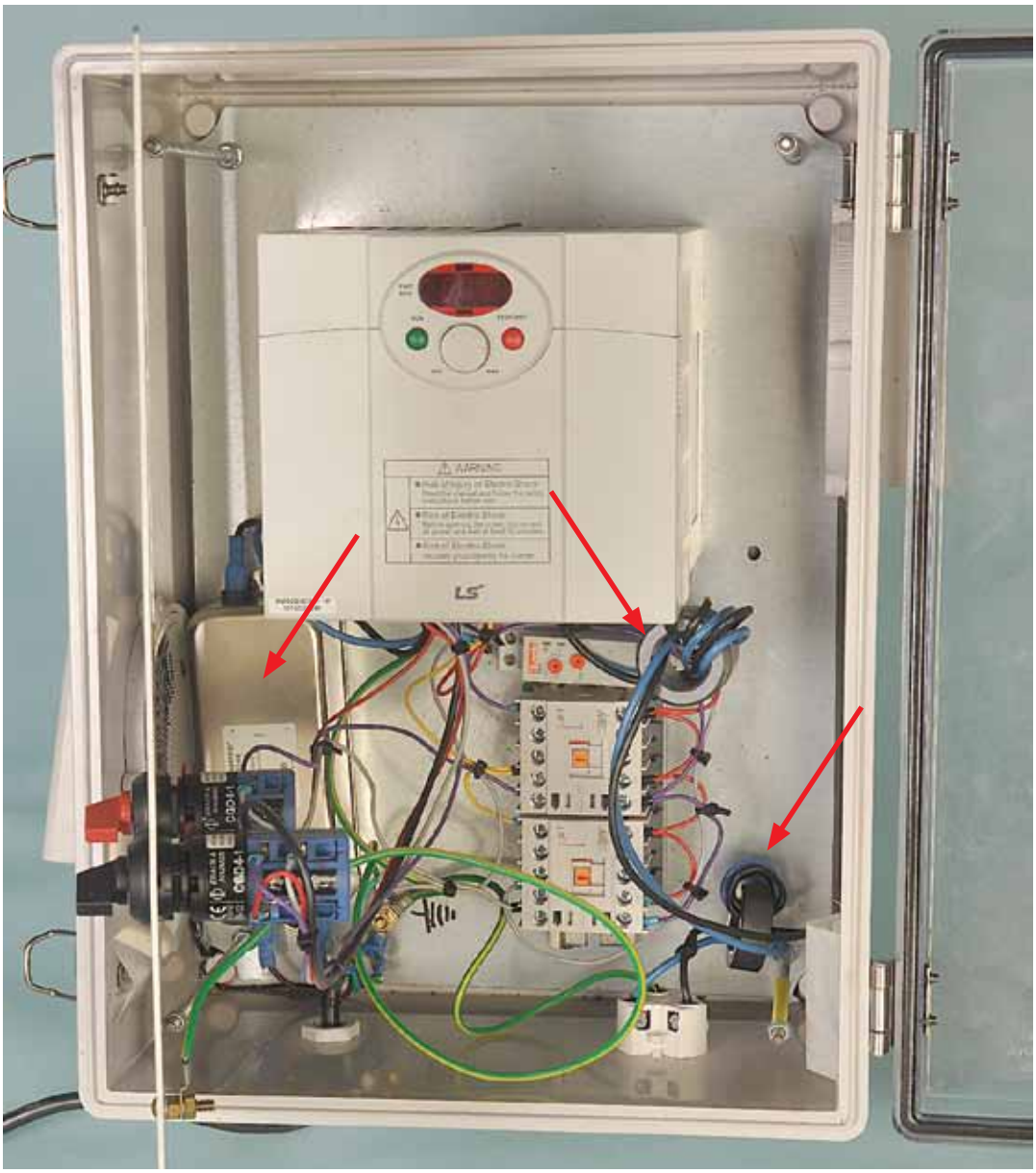
The FutureWave Energy Saver is, quite simply, a variable-frequency motor drive. In fact, the device is based on a purpose-designed VFD (a SV02iC5-1 module, made by LS Industrial Solutions of Korea).

This module will handle up to 2.2kW (3hp) motors so the FutureWave is capable of handling the largest domestic pool and is, in fact, now being used at quite a few large community pools. Incidentally, according to specs we found on the 'net, this particular LS VFD module can also be used





The FutureWave Energy Saver is based on a Variable Frequency Driver (VFD) which has an H-Bridge output to drive the induction motor at reduced speeds. In effect, the VFD switches the H-Bridge output devices (Mosfets or IGBTs) with a high frequency variable pulse width signal to synthesise a low frequency sinewave (more or less) at 50Hz (full power), 38.5Hz (low saving), 35.5Hz (med saving) or 31.5Hz (high saving). These scope waveforms show the actual signal delivered to the motor and as you can see, there is a considerable high frequency component still present. This does not affect the motor's behaviour but it can cause AM radio interference (depending on the signal strength in your area).



Inside the FutureWave Energy Saver, with the front panel "folded back" 90°. The large module at the top is the Variable Frequency Drive (VFD) module which is the heart of the system. The large silver EMI suppressor (behind the switches) and the two toroid rings through which the power lines pass (all highlighted with arrows) should be capable of minimising radio frequency interference. They don't work real well in low signal areas!

to convert single-phase AC to three-phase (but of course, this feature is not used in the FutureWave application).

As you no doubt know, the speed of an AC induction motor is "locked" to the mains frequency – in our case, 50Hz.

Ergo, if you vary the frequency, you vary the speed of the motor. As long as you continue to supply sufficient voltage to keep the motor spinning, it will happily run at the lower speed.

In a nutshell, this is what the FutureWave Energy Saver does – it varies the supply frequency. The clever bit, at least as far as we are concerned, is in the programming – what length of time do the various modes keep running and of course, at what frequencies.

Table 1 below shows the theoretical rotational shaft speed of a (typical) 2-pole induction motor at various frequencies.

Note that this *is* theoretical – for a number of reasons, to do with slip and load, the actual speed of the motor will be less than this. Typical 50Hz 2-pole pool pump motors, for example, will have a nameplate rating of about 2800-2850rpm, or about 5% less than the synchronous speed.

So where does the power saving come in?

It's quite simple, really: run a motor at its normal (rated) speed and it uses maximum power. Maximum power equals maximum energy cost. Slow the motor down and, as long as it can continue to do the work required, the power (and therefore energy cost) decreases.

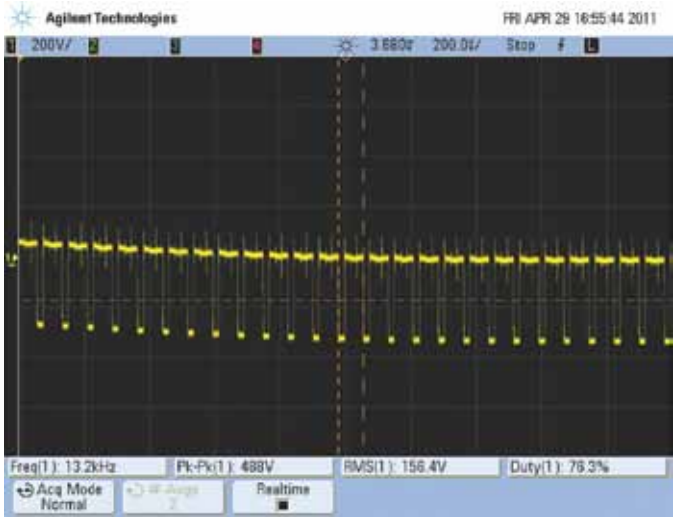
There does comes a point, however, where the motor will start getting rather cranky at running too slow. Heat dissipation from the windings can become a major problem (most induction motors have fans built in to assist in cooling), as does actually being able to supply enough "grunt" to run the pump or whatever device the motor is turning.

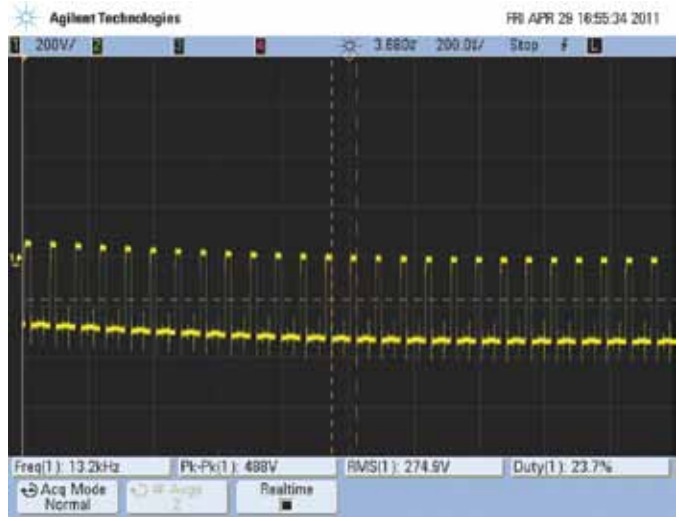
Soft-starting the motor

Another thing that the FutureWave does is "soft start" the motor. A rule-of-thumb is that starting current of an induction motor is around 500% of run current. This only lasts for a short time (perhaps half a second or so) until the motor is up to speed but in this time there is obviously a lot more power being used. By preventing this huge current at

Frequency (Hz)	Shaft rotational speed (rpm)
50	3000
40	2400
30	1800
20	1200
10	600

Table 1: Synchronous motor speed versus frequency





These two scope waveforms are taken at a much higher sweep speed (200us/div) than those overleaf to illustrate the variable pulse width of the synthesised motor waveform. The waveform with the high pulse duty cycle is delivered on positive excursions of the waveform while the low pulse duty cycle is equivalent to the negative duty cycle.

start-up, you're going to save money. Incremental savings, perhaps – but they all add up!

Wear and tear

Running a pool pump for several hours means it will get rather hot. You only have to see the large fins on most pumps to see that efforts are made to get rid of this heat.

It's the pump bearings which normally wear out first and if left unattended, or unnoticed, may cause the motor to seize, overheat and ultimately burn out.

Running the motor slower will result in cooler bearings, which in turn will result in longer bearing (and therefore motor) life.

Our testing

We did two different sets of tests – one in our laboratory, where we were able to capture the scope waveforms shown here, while the second was done "in the field" using a real pool pump on a real pool.

The lab tests showed the unit worked and did exactly what it was supposed to.

But there was a real sting in the tail – it was very difficult indeed to sync the scope on the waveform due to the large amount of noise on the waveform. The screen grabs show what we are talking about.

Our lab tests also showed that the voltage delivered to the pump was also reduced, along with the frequency. While nothing like a sine wave, we were able to get the scope to give us "RMS" voltage readings for the three different settings. These are reproduced below with the consumption readings.

Our "real world" test setup was quite simple: we used a 1.3hp pump already installed on a 50,000 litre pool. In line with the 230V power outlet (ie, before the pump) we placed a SILICON CHIP Energy Meter (see July 2004 issue) which gives an instantaneous reading in watts plus a cumulative reading in watt-hours (or kilowatt hours).

We then ran the pump "as is" for two hours, then five hours. The two different periods were to not only ensure statistical accuracy; the higher run time is typical for a domestic pool in summer and the lower typical for winter use.

These two readings were entirely consistent with what we would expect:

Full power: 2 hours - 1.964kWh 5 hours - 4.953kWh
(Power reading after "settling down" 1.01kW)

Then we placed the FutureWave Energy Saver in line and repeated the tests, with the energy saving level set to all three positions in turn (via the switch on the front panel of the unit). Remember, the "high" position is actually the highest energy saving, or in fact the lowest power setting.

As we mentioned earlier, we weren't able to duplicate the 80% power savings claimed by FutureWave Technologies. But we were able to demonstrate quite significant savings, more than enough to justify the claim of an "energy saving device":

High: 2 hours - 675Wh 5 hours - 1.7kWh
(Power reading after "settling down" 353W)
Frequency: 31.5Hz
Pump voltage: 122V (RMS)

That's a 66% reduction in power and is almost the same percentage reduction for both 2 hours and 5 hours, again as we would expect. As we said, not 80% but certainly getting up there and certainly worthwhile.

We repeated the tests with the FutureWave set to medium and low energy saving levels and the results were, of course, not as good but good nevertheless:

Medium: 2 hours - 975Wh, 5 hours - 2.42kWh
(Power reading after "settling down" 486W)
Frequency 35.5Hz
Pump voltage: 140V (RMS)

Low: 2 hours - 1.15kWh, 5 hours - 2.74kWh
(Power reading after "settling down" 575W)
Frequency: 38.5Hz
Pump voltage: 161V (RMS)

One point to note: running the pump through the FutureWave set to "Full Power" consumed 55W more than running the pump direct from the mains, so this is the FutureWave's "overhead" and also should be taken into account when calculating power savings. Of course, running the system through a mains time switch would mean no overhead for

FutureWave comments . . .

Silicon Chip provided a copy of the review to FutureWave prior to publication, for any comment. Rather than amend the original article, we decided to publish their response verbatim for readers to consider. Here's what they had to say:

Hi Ross,

Thank you very much for forwarding the article. We were very glad to see that the Future Wave Energy Saver performed as expected when running on a smaller 1HP (0.75kW) pump such as your pool pump Ross.

From our perspective we would like the opportunity to provide some feedback regarding some of the comments and findings in the article.

1. Firstly to clarify the structure of the companies – The inventors/developers & manufacturing side of things is through 'Future Wave Innovations Pty Ltd'. Our company 'Future Wave Energy Solutions Australia Pty Ltd' work direct with the manufacturers as the client facing sales side. Currently there are only a few smaller Re-Sellers out there but within the next few months there will be a proper robust Distribution Network put in place with a view to rolling out a nationwide accredited Reseller Network. So, just clarifying, we (Future Wave Energy Solutions Australia Pty Ltd) should not be referred to as the 'Developers'.

2. I wasn't made aware that the Future Wave had turned up without an instruction manual and had we been made aware of this we would definitely have provided one immediately. I have attached a soft copy of the information and instructions that are included with every Future Wave. The Future Wave that was redirected to Silicon Chip was one that was already sent to a customer in Sydney to trial and instead of sending it back to us in Queensland we thought it easier to have it sent on. Obviously they did not send it with the provided instructions etc. The buttons and dial that is referred to in the article are only used for the initial programming of the Future Wave after which they are programmed out so that no tampering can occur. In some 'Custom' cases the 'Medium' setting on the energy saving dial may be programmed to be variable and then the dial on the VSD would be used to adjust the frequency of the unit with Maximum and Minimum parameters set so the user can't inadvertantly do any damage.

3. The article makes comment on the claims of 'up to 80% savings' but the Silicon Chips test results showed results in the high 60's. This should be clarified that when we refer to 'up to 80%' it obviously means only in some cases. Results will vary for every pump depending on the size of the pump, load, make, model, age of the pump etc. The higher saving results are normally seen on larger pumps (1.5kW-2.2kW) and typically when running smaller pumps like the one tested (0.75kW – 1.0kW), we typically see closer to the 70% savings on average when running on the 'High' energy saving level. So we would say that your trial performed as we would have expected.

4. When referring to 'typical pool pump size' I think it is dangerous to say that for a 50,000 litre pool that a 1kW pump would be the norm. Pool pump sizes vary considerably depending on many factors, volume of water, filter design, complexity of the hydraulics, required turnover rates, climate, type of cleaner and so on. If I was having a guess for our climate in S-E Queensland and what would be typical, I would be estimating closer to a 1.5kW (2HP) pump would be the norm and a lot closer to what we generally see when selling or installing the Future Wave. Smaller pools under 50,000 thousand litres would typically utilise smaller pumps as you mentioned.

Also the reference to 'typical five hours per day for the swim season' as the general amount of time that an average pool pump would run also should be questioned. For a 50-70,000 litre pool through a warm to hot summer and the pool being frequently used, five hours would be dangerously close to the bare minimum that it should be running. Once again depending on many variables, pool size, pump size, climate, exposure, usage, type of filter, type of chlorinator, plumbing design etc. etc. this will vary considerably. I think you will find that generally any pool designer or pool maintenance professional will recommend running your pool for up to eight hours for water quality and hygiene purposes, especially on a 50-70,000 litre pool.

The further reference of '1-2 hours run time in the off-season' would be a very small minority of pool owners. There are over 500,000 pool owners in Queensland alone and the vast majority of these pool owners would be running their pool pumps for 3-5 hours at minimum throughout our small off-season, with a lot of pools now having solar water heating you will more than likely find that pools are being used year round and the pumps would be still running closer to 6-8 hours.

5. Point 4 above will obviously have an impact on 'typical savings'. You refer to a payback term of two years through savings. Once again this will not be the case for everyone but in some cases we frequently see payback periods under two years. This will obviously be when pool owners have larger pumps than the one you tested and they run for more hours a day. I think we should make it clear that with your test scenario used of two hours run time in winter and five hours in Summer on a smaller pump of 1kW we would not expect to see a two year ROI. On larger pools running larger pumps and running for eight hours or more a day then you will obviously see much better savings and payback periods. A fairly typical pool pump in Queensland of 1.5kW running eight hours a day on peak tariff of $0.2135per/kWh would be $233.00 per Quarter or $932.00 a year. At 70% savings this would mean a $653.00 saving per annum. At the price of $1295.00 this equates to pretty close to a two year payback period even if electricity prices were not to increase, but we all know this is not going to be the case and we will expect to see some pretty hefty increases meaning higher savings and a better payback period again.

6. Your findings of AM interference is a known issue and that is accepted but with thousands of units being currently used we are only aware of maybe a couple of individual instances that this has been an issue. The Future Wave Energy Saver passes all relevant Australian EMC standards and compliances. Further testing and development is being carried out with a view to address this concern. In individual cases where this is an issue we are happy to work with the customer to have it resolved. The quoted comment of 'no-one listens to AM anymore' is obviously used out of context and should be removed as I was the person who light-heartedly made that comment and I was quick to acknowledge that it was a known concern and that the designers were working on a fix and that I would take the findings directly to the designers to make comment on. We have been more than accommodating with giving Silicon Chip 'free reign' with their access to the Future Wave Energy Saver and ability to test it along with being available for comment and feedback and we think that this comment and the context of the paragraph makes us sound arrogant and dismissive of the issue which we clearly are not.

Overall we are obviously very happy that the unit tested well and the results are mostly positive but we would greatly appreciate the above comments be given consideration.

Kind regards,

Charlie Notting
Future Wave Energy Solutions Australia Pty Ltd

most of the time (ie, whenever it is off, it is OFF!).

Power cost

Let's translate that energy usage into the language everyone understands – dollars – using the same rates we used earlier.

Again, we are using the "high" setting. 1.7kWh per day times 265 days (summer) times $0.28; plus 675Wh times 100 days (winter) times $0.28, brings your annual pool power bill down to just $145.00. The lower energy usage may well keep you under the 1750kWh "premium rate" so you could even be paying around $98 per annum. What were those "full rate" figures we quoted earlier? Hmm: $400 and $300!

Noise

Here there is good news and bad news. The good news is very good and the bad news is, at least in my case, awful!

First of all, let me say that my pump is about five years old so by this time, you might expect quite a bit of bearing noise. Such is definitely the case: with the pump running on full power, we measured it at 79dBA @ 1m and 65dBA @ 5m, against a Sunday morning background level of 47dBA.

That's loud enough to be quite noticeable during the day but it's unacceptably loud during the still of the night. In fact, many councils have ordinances which prevent pool pumps being run after 9 or 10pm or before 6am – a time when many people on "smart meters" would prefer to run them to take advantage of significantly lower tariffs.

The good news

With the FutureWave Energy Saver in line and operating at its best saving rate, the noise level dropped to a much more satisfactory 72dBA @ 1m and 57dBA @ 5m. That's probably still too loud for night-time operation although, with a newer pump, it would obviously be significantly lower again. A modicum of sound-proofing around the pump may be all that is required. On the mid and low settings, noise was (respectively) 74dB/76dB @ 1m and 58dB/60dB @ 5m.

The bad news

If you like to listen to AM radio and you don't live in a relatively strong signal area, forget about using the FutureWave Energy Saver (at least as it is currently configured).

Let me explain that: while I'm only about 20km from the centre of Sydney, radio and TV signal levels at my place are renowned to be low, mainly due to topography.

I would equate the level of signal as akin to that of a country town, where the "local" radio transmitter can be many kilometres away; perhaps even several towns away (and may be fairly low power into the bargain).

My pool pump is virtually on the back boundary of my property (a standard 15 x 45m suburban block). My house is set well forward on the block.

No AM radio reception was possible anywhere in the house or yard when the FutureWave was turned on – in fact, my partner has never moved so fast, to turn any radios off when that "damnawful noise" started! I'm not simply talking about mains-powered radios where the interference could have been introduced via the mains wiring. I'm also talking about interference on a battery powered portable, not just on my property but right across the road – a distance of about 65 metres from the offending noise source!

I wasn't game to ask my next-door neighbours if they had the same problems as I (they'd know who to blame!) but clearly if I was having reception problems at 65m, the odds were pretty good (or is that pretty bad?)!

The FutureWave does have EMI suppression built in, as our photo clearly shows. However, it just as clearly is inadequate if your AM radio reception is not strong.

I mentioned this problem to FutureWave after my tests and they were aware of the problem but were, if not dismissive of it, didn't think it too big a problem. Their comment: "no-one listens to AM radio any more . . ." I've got to tell them that this little black duck does, as do many friends and colleagues.

They did say that the designers were aware of the interference problem and were working on a "fix". I hope for their sake the fix is quick – otherwise I suspect that many users, especially in country areas will say "bugger the savings – I want my radio reception back."

How much?

It's not easy to get a price for the FutureWave Energy Saver. Everyone wants you to contact them and they will get a "representative to contact you" who will then tell you the price. Perhaps the reason for this is that it is sold through a variety of on-sellers who may wish to provide extra services at installation (particularly if they are pool shops, etc).

But the FutureWave Energy Saver doesn't need "installation" as such – it is quite suitable for the do-it-yourselfer to put in (how hard is it to unplug the pump power lead and plug it back in via the FutureWave?).

So many readers may want a "supply only" price, as distinct from a "supply and install".

We believe the "supply only" price is around $1295.00 – at least, that's the only price we could find on the 'net (there were plenty of suppliers offering the FutureWave but with only one exception that we could find, all remained pretty coy about how much it cost. Most simply claimed that you would save the cost back in two years, or words the that effect).

Incidentally, we have a bit of a problem with that particular claim. As we noted earlier, two years at full electricity tariff is about $800; our measurements suggest two years with the FutureWave is at best about $180. The difference is a bit over $600 – a fair way short of the $1295 FutureWave cost. Four years? Now that's a different proposition.

Conclusion

OK, the FutureWave Energy Saver clearly works and will clearly save energy. With electricity prices slated to increase yet again this month, that saving can only be a good thing and will reduce the payback period of the unit.

Just how much you save also depends on which setting you run the FutureWave on, the length of time you run it (eg, does it keep the pool clean?) and whether or not you can take advantage of lowest electricity tariffs. If all your ducks line up, the savings can be quite significant.

However, until that interference problem is fixed, anyone with a FutureWave, especially in the country but even city dwellers who don't have strong radio signal levels, may well run into AM radio reception problems – if not themselves, with neighbours up to three houses or more away. SC

For more information on the FutureWave Energy Saver, and a list of suppliers, visit the company website, www.futurewaveenergy.com.au, or call Futurewave Energy Solutions Australia on 1300 979303.
Postal address: PO Box 577, Mooloolaba, Qld. 4557