Addressing swimming pool and spa pump energy efficiency in Australia

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Abstract

In Australia, 12% of households have a swimming pool, and ownership is expected to rise to almost 15% (1.32 million pools) by 2020. Pool pumps can be responsible for over 15% of a household's electricity consumption.

In 2010, pool pumps in Australia consumed 2156.9GWh, which is over 3% of total household electrical energy use (66,556 GWh).

Considerable opportunities for energy savings exist through the use of more efficient pumps and by pumping water through the filter at reduced flow rates. The increasing use of multi-speed and variable speed pumps allow a much lower flow rate to be used for most of the time for filtration and then higher flow rates only when cleaning is required. There has been a tendency to over-size pool pumps.

In April 2010, a Voluntary Energy Rating Labelling Program (VERLP) commenced with support from manufacturers and suppliers. The ten largest manufacturers have tested and labelled over 35 of their more efficient pool pump-units. Industry has also undertaken significant research and development leading to increases in efficiency of single speed pumps and a shift to more energy efficient variable speed pumps.

Work is progressing on analysing the benefits of mandatory labelling and MEPS for pool pumps. This includes amending Australian Standard AS 5102 in response to issues that have arisen in the operation of the VERLP. This paper will also address the latest progress on the European Energy Using Product Preparatory Study on pool pumps. The VERLP is designed to draw the attention of consumers to the potential savings available by using energy efficient pumps; for instance, using an Australian tariff of 25 cents per kWh, a household can save approximately $260/year by switching from a two star rated pump to an eight star rated pump).

A regulatory proposal is also being developed to specify the integration of demand response interfaces for swimming pool pumps. This will help to manage the problem of peak electricity demand by creating a market for direct load control. The costs and benefits of direct load control are being investigated, including the option to mandate integration of a demand response interface in these products.

Background

Pool pump ownership

In 2010, approximately 1,288,500 Australian domestic households had pools or outdoor spas installed, representing 15.2% of Australian households. Of this, 1,019,000 were swimming pools (12.0%), while outdoor spa ownership was approximately 269,500 (3.2%).

Swimming pool installations fall into two main categories, above ground and in-ground. In-ground are the more popular, representing 84% of total pool installations in 2010 while above ground pools represented only 16%.

State	Number of Pools ('000s)
New South Wales	337.6
Queensland	312.3
Victoria	146.4
Western Australia	129.3
South Australia	57.1
Northern Territory	21.4
Australian Capital Territory	8.1
Tasmania	6.7
AUS	1,019.0

Table 1: Number of pool installations by State and Territory. (ABS, 2010)

Table 1 shows that over 60% of installed domestic swimming pools are located in New South Wales and Queensland. The scale of pool ownership broadly reflects general population sizes, but is also influenced by climatic factors within and between jurisdictions.

Energy use

Total residential sector swimming pool and outdoor spa electrical energy consumption in fiscal year 2010/11 was estimated at about 2156.9 GWh (projected to rise to 2,678 GWh by 2020 [Figure 1]). With a total residential electricity consumption estimated at 66,556 GWh (EES, 2008a), swimming pools and spas consume just over 3% of domestic energy use.

The annual electricity consumption of a pool can be estimated from the run times, the power of the pump motor (typically about 1 kW for a 50,000 litre pool), the time clocks and other controls (about 10 W) and the salt electrolysis cell, if present (about 180 W). A pool run for the recommended times will use about 2,200 kWh annually (the pump accounts for about 70% of the energy use [NAEEEC, 2004]). Some householders will over- or under-run their pool pump. If householders do not ensure that they reset the time clock, and thereby retain the summer settings all year round, electricity use could go up to 3,100 kWh per year. Even at 2,200 kWh the pool would be the largest single source of electricity usage in the average household, aside from households that use an electric water heater (Living Greener, 2013).

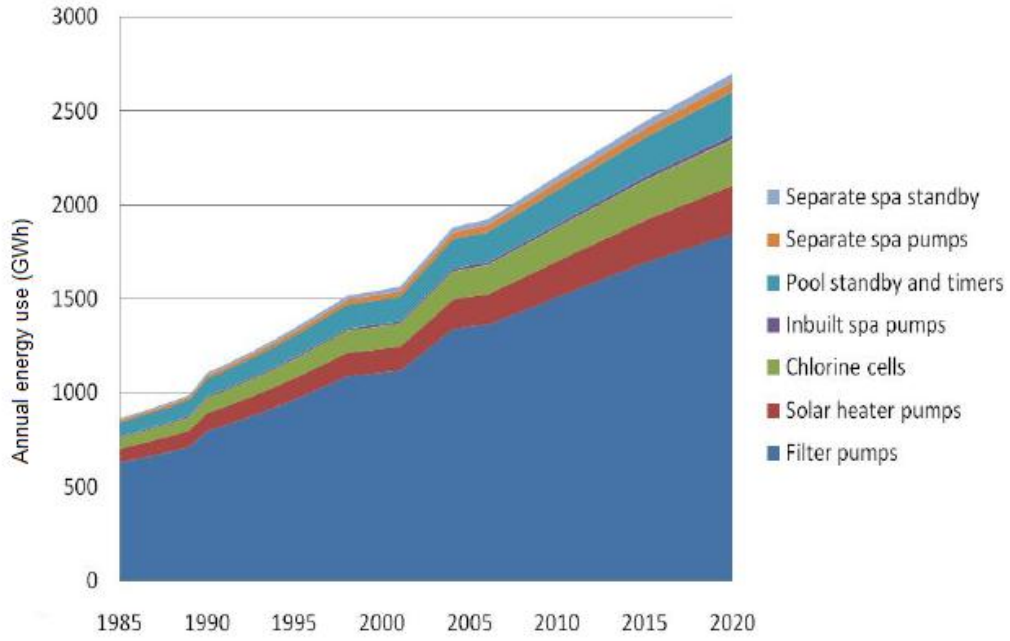

Figure 1: Projected annual energy use of swimming pool and spa pumps. (EES, 2008a)

Energy saving potential

The potential for delivering energy savings through the implementation of regulation can be approached in terms of the depth and breadth of the problem.

The depth of the problem

There is a wide range of efficiencies within the pumps available on the Australian market (Figure 2). This indicates that there is a potential for energy savings by obtaining a higher market penetration of the more efficient pump-units.

A good indication of the energy efficiency of a pool pump is the number of litres that it can pump per Watt hour, which is referred to as the ‘energy factor’. Pump testing undertaken in 2010-2011 revealed that energy factors for pool pump-units available in Australia varied from 11 to 42 litres per Wh.

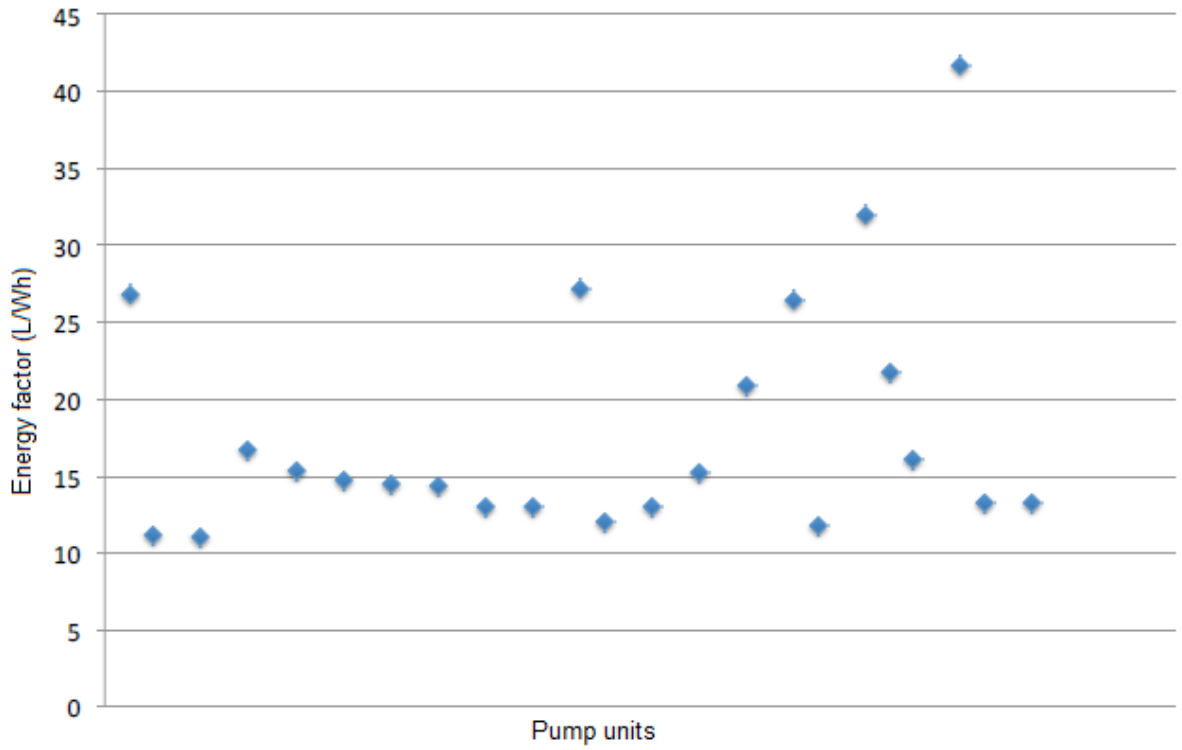

Figure 2: Pool pump test results. (Waterco, 2010)

Test results delivered by AusEng (2009) show that with the current Star Rating Index algorithm high performing pumps can deliver five times the efficiency of their low performing counterparts. As the pump is generally the largest energy user in a household (averaging 15% of the total household consumption [ESS, 2008]), there are potentially large energy savings to be made by using an energy efficient pump. (e.g. using an Australian tariff of 25 cents per kWh, a household can save approximately $260/year by switching from a two star rated pump to an eight star rated pump [Living Greener, 2013]).

As the lifetime cost of pool pumps is comprised of approximately 20% capital costs and 80% operating costs (mostly made up of energy costs) these savings may be considered highly relevant by consumers.

The breadth of the problem

In regard to the breadth of the problem, swimming pool and spa pump-units comprise over 3% of residential energy consumption. Excess consumption by inefficient pump units could potentially represent a large percentage of the total consumption. The scope of the problem is therefore large and significant enough to allow consideration of options to address the issue.

Voluntary Energy Rating Labelling Program

Concept

Swimming pool pumps consume high amounts of energy. In most households, they are the single largest source of electricity usage. Unfortunately, there is very little information available to pool owners about how much energy is used by their swimming pool pump-units. Energy efficiency labelling, using the Energy Rating Label, would address this information failure to the benefit of consumers without significantly altering price, product quality or the competitiveness of the market.

Implementation/rules

While there is no obligation for swimming pool pump suppliers to participate in this program, if a supplier does decide to participate and attach the Energy Rating Label to a particular pump, the supplier must abide by the following rules:

- Suppliers who choose to participate in the Program, and give notice to the administrator that they intend to label specific qualifying pump-units, must provide a copy of all the test reports containing the test results in relation to those pump-units to the administrator. In-house test reports are acceptable.
- The supplier must cover the costs of the testing.
- Suppliers are responsible for adhering to these rules and for ensuring that their authorised representatives (advertising agencies, dealers, retailers, etc.) also adhere to these rules.

Current status

The VERLP was launched in April 2010. Participants in the Program include the 10 largest international manufacturers who have registered 35 pump-units to date (with 3 more applications currently being processed).

Manufacturers tend to register only their high performing, energy efficient pumps under the labelling program. Star ratings of registered pumps range from 5.5 to 8 stars. A report on minimum energy performance standards and labelling conducted by Beletich Associates (2012) found that pumps labelled with the Energy Rating sticker sold well in comparison to those that did not. In order to truly assess the impact of the VERLP we would require data on the sales of pool pumps before and after being registered under the program.

Issues

Since April 2010, the VERLP has provided invaluable real-world experience of pool pumps testing and the energy labelling algorithms. This experience has led to the discovery of a range of issues:

- Motor characteristics are strongly temperature dependent, mostly because of the effect of temperature on motor winding losses. The temperature of the rotor is of particular importance, because slip at a given load torque, and therefore shaft speed, is significantly influenced by rotor circuit resistance. In order to be able to make reproducible measurements on a given motor, these measurements must be made when the temperature is stable, ideally at a fixed ambient temperature. The Department of Resources, Energy and Tourism recently opened the standard for peer review and is in the process of incorporating a requirement for conditions which constitute temperature stability in rotating electrical machines, such as those described in IEC 60034-1.
- In the manufacturing stages of an electric motor, depending on the test procedures, it will be run for varying amounts of time at varying speeds. In some cases, the testing is not long enough to “run-in” the motor. Regardless of temperature stability, motor performance will not stabilise until seals have been worn-in and bearings have been sufficiently coated in grease. We are therefore incorporating a provision for a “run-in” time to the standard.

Proposed Mandatory Program

Market problem – justification of regulatory proposal

To make an optimal purchasing decision, a consumer needs to consider two different types of costs with regards to the purchase of a pump-unit: the initial up-front, or capital, cost of the pump-unit; and the running cost or operational cost of the pump-unit. In an optimal situation, users would consider the total lifetime cost of the pump-unit and act to minimise that cost.

Currently, it is difficult to obtain information on the energy efficiency of a pool pump before purchasing it. As such, it is not unreasonable to speculate that consumers are purchasing pump-units with little consideration of the lifetime cost of the device. As energy operating costs can comprise 80% of the lifetime cost of the pump-unit, choices made without consideration of operating costs are unlikely to be efficient.

Further information is required on whether purchasing decisions are driven by factors other than energy consumption. There could be other product features that have a stronger appeal to customers than energy efficiency. For instance, there are secondary functions (such as backwashing) on swimming pool pumps that can require high powered performance over short time periods – having the capacity to reach these higher power requirements could potentially affect the energy efficiency of the device during normal operation. More data is needed to understand this issue.

Many new swimming pool pumps are sold as part of a complete pool package. The pump normally comprises only a small part of the cost of installing a pool and may therefore get little attention from the purchaser. This is demonstrated by a survey by Winton (2009) that states that only 50% of owners can recall the brand of their current pool pump. Installers who are not emphasising the eco-benefits of their products may try to reduce their costs by including a cheap pump-unit. Pumps tested under the VERLP have shown that there is a correlation between the efficiency of a pump and its price. This indicates that some pool owners may be obtaining inefficient pumps without being adequately informed.

According to a report by AusEng (2009), 30% of pump sales are provided by pool servicers as a replacement for defective pumps. This process often starts with owners having pool service suppliers assess if a broken pump can be repaired. In cases when a replacement is necessary and insurance does not require the pump to be replaced with an identical model, owners frequently take the recommendation of service staff. Recommendations of service staff can be based on a number of considerations:

- Some servicers have preferential pricing arrangements with manufacturers for certain brands or models, thus making the sales of particular brands or models more attractive to them. In this case, it is unlikely that the energy efficiency of the pump will be a major consideration.
- For ease-of-connectivity reasons, servicers could recommend replacing a pump with the same model or one with similar fittings. In this case energy efficiency may be a consideration if it was considered when the original pump was purchased.
- Servicers may make their recommendation based on their own financial interests (generating revenue and/or profit for their business). In this case there may either be an incentive to promote the energy-efficient pumps or the larger, less efficient pumps as they are both at the more costly end of the spectrum.

These practises are poorly understood at the present time. It is hoped that the consultation period of this regulatory process will expand our knowledge of this.

Scope

The proposed scope Australia is investigating will cover all pump-units intended for use in the operation of residential swimming pools and spa pools that:

- Are used for the circulation of water through filters, sanitisation devices, cleaning devices, water heaters (including solar), spa or jet outlets or other features forming part of the pool.
- Are single phase.
- Are capable of a flow rate equal to or greater than 120 L/min.
- Are single-speed, dual-speed, multi-speed or variable speed.
- Have an input power of less than or equal to 1800 W for any of the available speeds.

Regulatory options

Maintain the status quo

Under business as usual (BAU), suppliers will have the option to register their products and undertake testing for the purposes of energy efficiency performance. However, this will not be a requirement in order to supply pool pumps to the local market. The voluntary labelling scheme aims to present highly technical information in a format that can be readily understood and provide consumers with a comparison of the energy performance standard of one product to another. The voluntary program has been effective in drawing attention to the scope of the problem at hand and has provided high quality data evidence to be used in a regulatory investigation.

As time progresses under the BAU option, there are likely to be changes to the current market arrangements. The market is likely to respond to the problems to some degree. As consumers become more aware of energy use they may better understand operating costs and suppliers may therefore have greater incentive to provide information. Higher energy costs and increased recognition of greenhouse gas implications could further encourage this. Technological progress in the development of pool pump-units globally will also provide for improvements in the energy efficiency of pump-units in Australia.

Implementing a mandatory labelling scheme

By extending the voluntary labelling scheme to a mandatory one, all pool pumps supplied in Australia would be required to be registered and carry a label describing the energy performance of the particular model. This will overcome information barriers caused by the difficulty to estimate the lifetime cost of a pump unit. It will provide the opportunity for rational purchasing decisions for consumers.

Implementing mandatory Minimum Energy Performance Standards (MEPS)

Under a mandatory MEPS scheme a supplier will be subject to certain energy performance standards for their pool pumps. Responsibility for compliance will lie with the supplier of the products. Each product (or family of products) will need to be registered. The mandatory MEPS would apply to new stock of pool pumps within the scope of the standard that are manufactured or imported on or after the implementation date. A decision as to the stringency of the MEPS would be necessary. A MEPS at an energy factor of 11.25 L/Wh for instance would remove any pump rated below two stars on the current Star Rating Index and will preclude machines above 1800 W.

The main concern from a policy perspective is the potential for a mandatory MEPS to reduce the choices available to consumers. By its nature, a mandatory scheme will reduce choice or force suppliers to use better components to make products compliant. This however, is part of its benefit, as it prevents consumers from making sub-optimal decisions that result in over-consumption of energy.

Implementing both Mandatory MEPS and Labelling

This would combine the above schemes, aiming at both eliminating poor performers and allowing consumers to make choices from the remaining products.

Issues arising

For evidence-based policy making on swimming pool pumps there is a requirement for high-quality data in order to:

- Understand the current economic situation;
- Evaluate the efficacy of the existing program (the VERLP); and
- Prioritise future programs and interventions.

Only partial data is currently available and while it is hoped that the consultation period of the regulatory process will deliver some of the data required, this is not guaranteed. The greatest concern in delivering evidence based policy is obtaining reliable, high-quality data.

Finally, a swimming pool system curve for the purpose of rating pump-units can be challenging to establish. There are numerous variables and configurations of pool hydraulic systems, which can affect the energy consumption of the pool pump. These include:

- Filter type.
- Pipework material, internal diameter, length and number of elbows.
- Type and number of pool fittings.
- Presence of pool heater, chlorinator and suction cleaning device.
- Pool size.
- Pump operating regime, including frequency of backwashing (to clean filter and thereby reduce pump head).
- Pump efficiency.

With the great variety of Australian pool designs, finding a single pool system curve to represent the 'average pool' is problematic.

EU perspective

In Europe, the European Commission is funding an Energy Using Product Preparatory Study on various types of pumps, including domestic swimming pool pumps. This study is being conducted by Bio Intelligence (France) and Atkins Ltd (UK), and is due to be completed by mid-2014. The objective of this work is to provide robust techno-economic analysis of the technical and economic energy saving potential of improved swimming pool pumps, from which policies for the EU-27 countries can be developed. It is estimated that there are almost 5 Million domestic swimming pool pumps in Europe, consuming 18 TWh of electricity per year, so even small savings would have a significant impact on carbon emissions.

Policies may either be of the form of mandatory regulation or of a voluntary agreement with manufacturers. Options include labelling, information requirements or Minimum Energy Performance criteria. At the time of writing this paper, there was no clear indication of the form that any such market intervention will take, but it is expected to include consideration of both the efficiency of the motor and pump, and the effectiveness of the controls. Initial challenges include characterising the existing market, and also understanding clearly the function of the pump, which is driven largely by necessarily conservative health considerations. This is further complicated by regional variations in required swimming pool pump duties. A key early observation is that the level of technical knowledge

varies considerably between different retail suppliers, with the end-user generally having only a modest understanding of how to optimise the pump use.

Details of the progress of the study, including completed interim reports, can be found at http://lot29.ecopumps.eu/ .

Demand/Response

Peak electricity demand is a growing problem for the electricity supply system in Australia. The electricity network infrastructure must be designed to cope with the highest demand for electricity, the cost of which is passed on to consumers. It is estimated that 25% of retail electricity costs is accounted for by peak demand that occurs for less than 40 hours per year (less than 0.5% of the year).

An important part of the solution to the problem of peak demand is direct load control (DLC). Under the DLC approach, consumers have a choice to allow certain household appliances, such as swimming pool pumps, to be remotely controlled by their electricity provider, which will reduce the demands placed on network capacity at peak times. The main benefit of DLC is the reduced need for investment in costly electricity network infrastructure.

For a DLC market to operate, appliances must be equipped with a demand response interface. These interfaces enable communication between distribution network service providers and specific appliances. To achieve this, a proposal has been prepared to mandate the inclusion of ‘smart appliance’ interfaces in air conditioners, swimming pool pumps, water heaters and electric vehicle chargers. If this proposal is implemented, it will create a DLC market.

Modelling projects that DLC could permanently offset 3 to 5 years of growth in peak electricity demand. If these benefits were passed on to all householders equally, it could result in a reduction in electricity bills of $60 to $120 per household per year from 2014 to 2028.

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