



## **A Review of the Heat Pump Water Heating Industry in New Zealand**

### **Summary of the April 2007 report by Dialogue Consultants**

New Zealanders are now familiar with heat pumps as space heaters. These were introduced in the form of reverse cycle air conditioners, but have become known primarily as heat pumps. These are selling in large numbers. Not so familiar, at least as yet, is the use of heat pumps to heat domestic water.

### **1. Suppliers**

All models of mass produced HPWH's sold in New Zealand until 2006 came from Australia. With excess demand in Australia, supplies to New Zealand virtually stopped. In consequence awareness of HPWH's is much lower in New Zealand than in Australia.

The brands and their suppliers have been:

1. Rheem Heat Pump by Rheem New Zealand;
2. Dux Heatpro by CJ Energy Services; and
3. Quantum by EcoSystems and Be Energy Efficient.

In addition a bespoke manufacturer in Auckland, Hot Water Heat Pumps, has been selling the Performance Plus model.

Improving technology, a perception that there is a market opportunity, plus the spread of HPWH technology to Asia, has led to two New Zealand organisations developing their own designs, and to the importation of units from China. The New Zealand developers are:

1. Matrix Engineering; and

2. Noske-Kaeser

Both have units at an advanced stage of development and in-service testing.

At least two businesses are in the process of importing heat pump units from China. These are:

1. Climate Zone; and

2. Air Temperature Control

At this time only two of these units are available for purchase in significant numbers, the Rheem and Quantum units. The Dux Heatpro has been replaced by the Airoheat in Australia, but this unit is being slightly modified to suit it to the New Zealand climate.

## **2. Installation**

There are two distinct types of HPWH:

1. Split arrangement, which has the heat pump unit separate from the storage cylinder. The heat pump is usually outside while the cylinder is located to serve the wet areas of the house, but the cylinder may be alongside the pump unit; and

2. Integral system, which has the heat pump mounted on top of the cylinder to form a single unit.

In general the split arrangement is best suited to retrofits, as it enables the existing cylinder to be used. The integral system minimises installation work for new houses. Since the demand in Australia is driven by regulatory controls on new homes, the newer Australian models are both integral designs. The models being developed in New Zealand, and the imported models to date, are oriented more to the retrofit market and are all split systems.

Both systems require that water pipes and a power supply be taken to the outside of the house. In this they are in the same position as instantaneous gas heaters. For a new house this is simple and inexpensive. For an existing one the problems vary widely depending on the house arrangement.

Finding an acceptable site for the unit outside the house can be an issue. They are not ornamental, and the tanks of the integral models take up a significant space, while freeing up space within the house.

### **3. Regulatory Requirements**

The split arrangement requires some training for installers, to enable them to correctly install the interconnecting pipes. Aside from that the capability and requirements for the use of registered tradesmen are the same as to install a conventional storage water heater.

For a new house the consent requirements for a HPWH are identical to those for a conventional water heater. For a retrofit and building consent will be needed for any additional plumbing.

### **4. Standards**

Due largely to the lack of market penetration of HPWH's outside Australia to date there are no directly applicable standards in operation elsewhere. The Australian/New Zealand standard, AS/NZS 2712: Solar and Heat Pump Water Heaters, Design and construction applies, but this is primarily for solar heaters and is very generic for HPWH's with no recognition of the different types and configurations.

The potential for HPWH's to substantially raise the efficiency of water and space heating has been noted in the IEA, which organised a research programme to coordinate national research efforts. This has produced a draft international standard for both measurement by testing, and estimation by modelling, the year round efficiency of combined (space and water) heat pumps. The European standards organisation CEN now has a project to create a European standard based on this.

There is an existing local standard, AS/NZS 4234:2006 Solar water heaters—Domestic and heat pump – Calculation of energy consumption, which relates to estimating energy performance by modelling, but not by testing actual units. In relation to HPWH's it applies only to solar assisted units. The Quantum brand was once such a design, but there are no longer any solar assisted models on the market. The standard has other shortcomings as far as HPWH's are concerned, e.g. the climate zones in the standard are based on irradiance. Irradiance is basic to SWH performance, but air temperature is more relevant to HPWH's. The zones defined in NZS 4218 and NZS 4243 for the energy efficiency of buildings would be more relevant to heat pumps.

A better standard for modelling HPWH performance, and one for testing them, is needed. Although the draft standard produced by the IEA is not directly applicable to HPWH's this could provide a helpful basis.

## 5. Other Issues

### 5.1. Drinking water

AS/NZS 2712 requires that HPWH's use a vented double walled heat exchanger between the refrigerant and the water. This requirement imposes cost and performance penalties. No such requirement is imposed on SWH's although the fluids used in them may also be toxic. The Building Code G12, Section 3.2.1, requires that there be "*no likelihood of cross-connection between*" the water and refrigerant pipes. The code gives no indication of acceptable measures.

### 5.2. Legionella

The Building Code G12, Section 6.14.3, requires that thermostats "*shall be capable of being set at a temperature of not less than 60°C*" It is not clear whether this is satisfied by a HPWH which may not use the tank mounted thermostat. A draft revision to Clause G12 proposes setting a minimum temperature in the storage cylinder to be reached at a set maximum time interval. The temperature and frequency are still being discussed. This requirement is of more significance to SWH's than HPWH's.

### 5.3. Freezing

Nearly all models involve water being taken outside the house's thermal envelope to be heated<sup>1</sup>. In the event of the unit being switched off during winter this exposes the system to possible damage from freezing. To avoid this, units should be compliant with AS/NZS 3500.4:2003 which requires an ability to prevent freezing after eight hours exposure at -5°C.

### 5.4. Durability

The Building Code specifies durability requirements for building components. That for storage water heaters (including

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<sup>1</sup> A potential exception is a system in which refrigerant, rather than water, moves between the heat pump and the storage cylinder. It is not clear whether a model with this arrangement will be marketed in New Zealand.

conventional ones) is set at 15 years, even if the cylinder has easy access. The cylinder manufacturers consider this completely unrealistic, but were not consulted. This requirement applies to HPWH's (and SWH's). No heat pump can hope to meet this requirement, but there two possible escape clauses in that:

- a) it is not clear that the Building Code requires hot water to be heated. The Acceptable Solution is to have a thermostat capable of being set to 60°C, with no specified requirement for water to be heated to this temperature<sup>2</sup>; and
- b) if the HPWH has an ability to default to a heating element, or for this to be recommissioned, in the event of a heat pump failure this might constitute an ability to satisfy the code.

### 5.5. TTMRA

New Zealand and Australia both have MEPS requirements for hot water storage cylinders, but the requirements have not been aligned. Under the Trans Tasman Mutual Recognition Agreement (TTRMA) water storage cylinders exported from Australia are acceptable in New Zealand if they are acceptable in Australia. As a result the cylinders in the HPWH's coming from Australia do not meet the more stringent New Zealand MEPS. This gives a small cost advantage to the Australian models over New Zealand produced ones, at the expense of energy efficiency.

## 6. Uptake Barriers

The industry participants perceived a wide variety of obstructions to further market penetration by HPWH's. A substantial number of these relate to the present low level of awareness of HPWH's even within the energy industries, let alone the general public. These have been banished in Australia, and will disappear once HPWH's are better known. Generic marketing could accelerate the process.

A number of other perceived barriers relate to the design of specific systems, such as that designs are oriented to Australia and are not effective in a colder climate. These concerns can be eliminated by either the actual performance of models being sold or, if the New Zealand market becomes large enough to support the introduction of models of

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<sup>2</sup> But such a requirement may be added, see Section 5.2.

improved design for New Zealand conditions, the operation of the processes of competition. In both cases the introduction of a reliable means of assessing performance will be needed.

A few, such as the need to employ tradesmen, are not going to go away. They apply equally to conventional heaters, but do act against retrofits.

Government is considered to be unreasonably discriminating in favour of SWH's, when the suppliers consider that HPWH's can provide superior energy efficiency benefits.

A significant part of the water heater market is considered to be not being interested in, or willing to invest to obtain, energy savings.

The import of poorly performing units could have a damaging impact on the whole market, should this occur. Avoiding this damage requires a means of sorting the sheep from the goats, i.e. a standards means of assessing performance.

## **7. Costs**

Very considerable variation is possible in the costs of assembling a HPWH, depending on the design, quality of components, and sources of supply. One assembly suggests that a basic HPWH might be able to be produced at a factory door cost of around \$2,000, not including a storage cylinder. This would require a substantial volume of production. An appreciable margin would need to be added to cover development and overhead costs. Marketing, distribution and installation costs are additional to this.

An alternative approach is to import complete units from China, where there are several manufacturers. Pricing is not public, and open to negotiation, but appears comparable to the cost of local assembly. The total cost of an installed retrofit to an existing cylinder, in an uncomplicated situation, might then be possible for \$2,800, plus markup.

## **8. Experience in Other Countries**

### **8.1. Australia**

There is a strong market for HPWH's in Australia, driven by regulatory restrictions on installing conventional electric water heaters in new dwellings. The measures used vary by state. In addition the Federal Government has introduced a subsidy on HPWH's by including them in

the Renewable Energy Certificate (REC) scheme, worth several hundred dollars. The varying availability of gas also has a substantial influence.

In the areas without gas, especially in Queensland, solar was expected to be the dominant choice, but this has not proved to be the case. As a result demand for HPWHs well exceeded manufacturing capacity during 2006.

## **8.2 Japan**

The high cost of electricity and gas in Japan has led to a strong demand for HPWH's. The "EcoCute" design uses CO<sub>2</sub> refrigerant which enables a very high efficiency, at a higher cost. The government offers subsidies, for which the budget is heavily oversubscribed.

## **8.3 United States**

A single model of HPWH is available, but attracts few sales outside utility efficiency programmes in spite of a Federal \$300 tax rebate.

## **8.4 Europe**

There is little market penetration of HPWH's in Europe, although there is a manufacturer in Austria.

## **8.5 China**

A shortage of electricity has led to government promotion of HPWH's in this very price sensitive market. This has led to several manufacturers and substantial sales.

# **9. Business Models**

As might be expected in a very immature market, several different business models are being followed or proposed. The present ones range from direct to consumer to sale through plumber's merchants. Proposed models include sales through accredited agents, what might be termed direct to installer, and the recruitment of allies. In time the range of models will be narrowed by competition.

# **10. Conclusions**

This investigation has determined that:

1. HPWH's are capable of significantly reducing the electricity required to heat water in New Zealand. They are applicable in

many situations that do not suit SWH's. The reduction in electricity use achieved by the HPWH's now on sale is at least comparable to that of a SHW even in a situation that suits both;

2. heat pumps have not been used to provide domestic hot water until very recently. The reason was that traditional air-conditioning technology, based on the CFC refrigerants R12 and R22, was not capable of achieving a great enough temperature lift to provide water at an acceptable temperature from winter air. The original Quantum got around this by adding a solar panel as a heat source. The change to HCFC refrigerants relieved this constraint and enabled the past range of Australian HPWH's. The introduction of chlorine-free refrigerants with substantially higher operating pressures now makes even wider temperature ranges, and enhanced low temperature operation, feasible. The introduction of HPWH's using CO<sub>2</sub> refrigerant, initially in Japan, offers the prospect of even higher temperature ranges and efficiencies;
3. the HPWH industry in New Zealand had only a small capacity to supply HPWH units during 2006, but this situation is in the process of changing very substantially. Some suppliers are now able to supply a large volume of HPWH units. The numbers being installed are now limited only by the demand for this technology at the prices presently being offered;
4. installing HPWH's does not require substantial additional training beyond that undertaken by normal tradesmen and installation capacity requirements are not likely to alter the ability of the industry to scale up its output;
5. additional suppliers are preparing to offer units for sale. The increasing number of suppliers with varying designs of systems should, within a few months, transform the market from an oligopoly to a strongly competitive one;
6. the design of HPWH's has advanced substantially in recent years, and will advance further in the near future with the introduction of revised and new models. This will substantially improve the performance of HPWH's in colder areas;
7. HPWH's cannot be manufactured at the prices now prevailing for heat pump space heaters. This is mainly due to the higher costs for handling water and providing assurance of

maintaining potable water quality. The greater temperature lift required is also a factor;

8. a rapid introduction of HPWH's will depend on a significant effort in a campaign to improve the public's understanding of this technology;
9. a degree of Government support is likely to be necessary if rapid uptake is desired;
10. an important barrier to the acceptance of HPWH's is the lack of a standard means of assessing or comparing their efficiency under New Zealand climatic conditions. Without a relevant standard comparisons and measures are inevitably somewhat subjective and arguable. The existing standard that comes nearest to providing this, AS/NZS 4234 "Solar water heaters – Domestic and heat pump – Calculation of energy consumption", does not cover air source HPWH's;
11. public acceptance and uptake of HPWH's could well be enhanced by an energy efficiency labelling system. This would give assurance of quality and performance and discourage the introduction of badly performing models. A prerequisite is a standard for performance measurement that covers the types of air source HPWH's that are used in Australia and New Zealand; and
12. it would be premature at this stage of the development of the technology to introduce a MEPS for HPWH's. This is an option, should experience show that there is a need.

## **11.Recommendations**

The actions needed to enable HPWH's to make the contribution they are capable of in improving energy efficiency are to:

1. undertake the extension of AS/NZS 4234, or develop a separate standard, to cover the estimation of the performance of HPWH's more comprehensively, including the development of a TRNSYS model or models for the principal design variants;
2. develop a standard method for the performance testing of HPWH's, preferably in line with the work currently being undertaken by CEN;

3. investigate establishing, as an interim measure, an acceptable minimum performance for HPWH's for the purpose of inclusion in any programme of assistance or promotion. This should be measured at 10°C and 80% RH, which is reasonably representative of the conditions under which they will be used in most parts of New Zealand. This minimum COP could be set at 2.2;
4. once the industry has overcome its supply constraints HPWH's should be treated on the same basis as SWH's in any promotional programmes for energy efficient water heating; and
5. the development of an energy efficiency labelling scheme for HPWH's should proceed in parallel with the development of a standard for performance measurement for HPWH's.